A DICTIONARY

OF

SCIENCE, LITERATURE, AND ART.

VOL. II.

ORIGINAL TITLE

A DICTIONARY

OF

SCIENCE, LITERATURE, & ART:

COMPRISING

THE DEFINITIONS AND
DERIVATIONS OF THE SCIENTIFIC TERMS IN
GENERAL USE, TOGETHER WITH THE HISTORY AND DESCRIPTIONS OF THE
SCIENTIFIC PRINCIPLES OF NEARLY EVERY BRANCH
OF HUMAN KNOWLEDGE.

NEW EDITION,

EDITED BY

W. T. BRANDE, D.C.L. F.R.S.L. & E.

LATE OF HER MAJESTY'S MINT

AND THE

REV. GEORGE W. COX, M.A.

LATE SCHOLAR OF TRINITY COLLEGE,
OXFORD.

IN THREE VOLUMES.

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DICTIONARY

OF

SCIENCE, LITERATURE, AND ART.

G. The seventh letter of the English alphabet, but the third in those of all the Oriental languages, and also of the Greek. The form of our G is borrowed from the Roman alphabet. G, in English, has two sounds; before *a*, *o*, and *u*, and occasionally before *i* and *e*, it is the medial letter of the guttural order; the other sound, which it possesses only before *e* and *i*, is one of the medials of the sibilant series. The guttural G is liable to a variety of changes in different dialects and languages.

G, as a Roman abbreviation, is used for gratis, gens, gaudium, &c. G.V. signifies genio urbis, G.L. genio loci, and G.P.R. gloria populi Romani. As a numeral, it denoted 400. On the French coins G indicates the city of Poitiers; and in chronology it is the seventh Dominical letter.

G. In Music, a note of the scale corresponding to the *sol* of the French and Italians.

Gabardine or **Gaberdine** (Span. gabardina). A coarse frock or dress, mentioned by Shakspeare in the *Tempest* and *Merchant of Venice.*

Gabbronite (gabbro, the Italian name of a rock composed of Diallage and Felspar). A mineral found in a vein of titaniferous iron near Arendal, in Norway. It is a silicate of alumina, soda, and potash. It has also been termed *Fuscite* and *Compact Scapolite.*

Gabel (Fr. gabelle, said to be derived from the Teutonic word geben, *to give*). Any impost laid on commodities was originally thus termed in France: as, gabelle de vin, de draps, &c.; but the word acquired in the course of time the peculiar signification of a duty on salt, which is meant when the word *gabelle* is used simply. The gabel was first established in the early part of the fourteenth century, during the reign of Philip of Valois, and with a brief interruption of five years, from 1340 to 1345, continued to be levied down to the reign of Louis XVI., at which time the revenue which it produced was estimated at thirty-eight millions of francs. The distribution of this tax was most capricious and arbitrary; and it may safely be affirmed that the gabel was one of the greatest curses imposed on France previously to the Revolution.

Gabian Oil. A petroleum or mineral naphtha exuding from the strata at Gabian, a village in Languedoc.

Gabions (Fr.; Ital. gabbione). In Fortification, cylinders, open at both ends, made of twigs or bands of iron twisted round stakes. When filled with earth, they are used as a screen from the enemy's fire, and to revet parapets.

Gable (Ger. giebel). In Architecture, the vertical part of a wall at the end of a roof, from the level of the eaves to the summit.

Gadfly. [Œstrum.]

Gadoids, Gadoidæ (Gr. γάδος, *cod*). A family of soft-finned fishes, which belong to the section *Subbrachians*, or those which have the ventral fins below or in advance of the pectorals, and of which the cod-fish (*Gadus morrhua*, Linn.) may be regarded as the type.

The general character of the Gadoid family is as follows: Body moderately elongated, subcompressed, and covered with soft and very numerous scales; head smooth; jaws and front of the vomer armed with pointed, unequal, moderate, or small teeth, disposed in several rows, like a rasp; gill-openings large, and with seven rays; most of the species with two or three dorsal and one or two anal fins; stomach strong and capacious; cæcal appendages very numerous; air-bladder large, with strong parietes, often dentated laterally. The greater number of the cod tribe inhabit the seas of cold or temperate latitudes; their flesh is white and well-flavoured; they are very prolific, and constitute the most important subject of fisheries. The great sand-bank of Newfoundland is the most famous of the cod fisheries. [Fishery.]

Gadolinite. A silicate of yttria, found in Sweden, chiefly near Fahlun, and at Ytterby, near Stockholm, in imperfect green crystals, and

in amorphous masses, embedded in a coarse-grained granite. It was named after the Russian chemist Gadolin, who discovered in it a new earth, yttria.

Gadus (Gr. γάδος). [GADOIDS.]

Gaelic or **Gadhelic.** [ERSE.]

Gaff. The boom or yard extending the upper edge of what are called *fore* and *aft* sails. The gaff turns on the mast against which its thicker end rests; the mast, as an axis, occupying a semicircular cavity in the end of the gaff. This cavity is known as the *gaff's jaws.* It is supported by two independent ropes; the *throat halliards* at the mast, and the *peak halliards* at the outer end. It is steadied, when the sail is not set, by ropes at the extremity called *vangs.*

Gage or **Gauge** (Fr. jauge). In Architecture, the length of a slate, or tile, exposed beyond the lap; also the measure to which anything is confined. Plasterers use the word to signify the greater or less quantity of plaster of Paris used with the common lime and hair to accelerate the setting; bricklayers use it to express the state of mortar: thus, they say a mortar is gauged stiff, or thin, as it partakes of one or other of those qualities. Engineers use the word to express the distance between rails, the thickness of boiler plate, wire, copper, and other materials.

GAGE or GUAGE. In Physics, any apparatus for measuring pressure, force, height, depth or size. Thus the *gage of an air-pump* indicates the extent to which the rarefaction in the receiver has been carried. [AIR-PUMP.] The *steam gage* measures the pressure of steam in any vessel; the *wind gage*, the force of the wind; the *tide gage*, the height of the tide, &c. [ANEMOMETER; HYDROMETER.]

Gahnite. A native aluminate of zinc, called also *Automolite.* Named after Gahn, who first described it.

Gaillarde. The name of a lively dance peculiar to Italy, and supposed to have been practised by the ancient Romans, whence it is sometimes designated *Romanesque.*

Gainage. In old English writers, this word signifies the draught oxen, horses and their furniture, which were left free when a villein was amerced, that agriculture might not be interrupted.

Gaining Twist. In rifled arms, a twist or spiral inclination of the grooves, which becomes more rapid towards the muzzle.

Galactic Circle (Gr. γαλακτικός, *milky*). A term first used by Sir John Herschel to denote that great circle of the heavens to which the course of the Milky Way, as traced by the unaided eye, most nearly conforms. It is inclined, at an angle of about 63°, to the equator, and cuts that circle in two points, whose right ascensions are respectively about 0 h. 47 m. and 12 h. 47 m., so that its northern and southern poles respectively are situated in R.A. 12 h. 47 m., N.P.D. 63°, and R.A. 0 h. 47 m., N.P.D. 117°. This circle, Sir John Herschel observes, is to sidereal what the invariable ecliptic is to planetary astronomy—a plane of ultimate reference, the ground-plane of the sidereal system. [GALAXY.]

Galactic Poles. The two opposite points of the heavens, situated at 90° from the Galactic Circle.

Galactine (Gr. γάλα, *milk*). An ingredient in the sap of the *Brosimum Galactodendron*, or Cow-tree of South America.

Galactite (Gr. γάλα). A fossil substance, not unlike French chalk. When immersed in water, it has the colour of milk.

Galactodendron (Gr. γάλα, *milk*; δένδρον, *a tree*). [BROSIMUM; COW-TREE; GALACTINE.]

Galactopoietic (Gr. γάλα, *milk*, and ποιέω, *I make*). A term applied by some medical writers to diet and medicine supposed to promote the secretion of milk.

Galangal. A dried root brought from China; it has an aromatic smell, and a pungent bitter flavour, and was formerly used in medicine. The greater galangal is the produce of the *Kæmpferia Galanga*, and the lesser of the *Maranta Galanga.*

Galanthus (Gr. γάλα, *milk*, and ἄνθος, *a flower*). The Snowdrop genus, especially interesting in gardens as being the 'first pale blossom of the unripened year.' The common Snowdrop is *G. nivalis*; a larger and finer species, *G. plicata*, is a native of the Crimea.

Galatea. [ACIS.]

Galathea. A genus of long-tailed (*macrourous*) Crustacea, including some very beautiful species (*G. rugosa, strigosa et squamifera*), occasionally found on the British coasts. The true *Galathœa* have the thorax oblong or ovoid, the median antennæ produced, and the pincers elongated. This term is derived from the name of the nymph Galatea.

Galaxy (Gr. ὁ γαλαξίας κύκλος). The *Via Lactea* or Milky Way. This luminous zone, so remarkable in a clear night, must have attracted the notice of the first observers of the heavens, and its true nature seems to have been surmised at an early period. Manilius, in his *Astronomicon*, after alluding to the well-known mythological fable of its origin, asks—

> Anne magis densâ stellarum turba coronâ
> Contexit flammas, et crasso lumine candet,
> Et fulgore nitet colluto clarior orbis?

The explanation of the phenomenon here suggested, namely, the condensed light of countless multitudes of small stars so crowded together as to be individually undistinguishable, is ascribed to Democritus, and its truth was confirmed, or at least rendered much more probable, immediately on the discovery of the telescope, Galileo himself enumerating among the advantages resulting from his instrument, that of putting an end to the disputes about the nature of the Milky Way. About the middle of the last century, Wright of Durham, and Kant and Lambert in Germany, speculated on the connection of the phenomenon with the general arrangement of the stars in space; but the first who undertook a systematic examination of the galaxy with telescopes of adequate power

was Sir William Herschel, and to the indefatigable labours of this great astronomer, and to those of Sir John F. W. Herschel (who, during his memorable residence at the Cape, with the same telescope which had been used by his father, and by a similar process of examination, explored those regions of the sky which are invisible in our latitudes), astronomers are mainly indebted for the facts upon which any sound speculation respecting the constitution of the heavens can as yet be founded.

The Milky Way, as seen by the naked eye, presents the appearance of a succession of luminous patches of varying intensity. Its breadth is very unequal, in some parts hardly exceeding 5°, in others extending to 16°; and there is a part between Serpentarius and Antinous where the two branches into which it is there divided occupy together a breadth of 22°. Its course through the heavens is nearly that of a great circle inclined at an angle of about 63° to the equator, and cutting that circle in two points whose right ascensions are, respectively, 0 h. 47 m. and 12 h. 47 m. Struve remarks that the most condensed stratum does not lie exactly in one plane, but appears rather to be contained in two different planes inclined at an angle of 10°, and intersecting in the plane of the celestial equator, the sun being at a little distance from the line of intersection. This slight deviation from a great circle had been remarked at an earlier period, and Lambert supposed it might be occasioned by the place of the sun being not exactly in the middle of the zone, but a little on one side. It is convenient, however, in speaking generally of the system of the galaxy, to refer it to a great circle of the sphere; and the great circle to which it most nearly conforms has been named by Sir John Herschel the *Galactic Circle*.

At several parts of its course the Milky Way throws off streams or branches. In Perseus a branch is sent off which is traceable to a considerable distance. Another proceeds from a point near the star *m Puppis*, nearly on the southern tropic. In Argo it opens out into a wide fan-like expanse, nearly 20° in breadth, which terminates abruptly, and at this part its continuity is interrupted by a wide gap. At *α Centauri* it again subdivides. At *γ Sagittarii* it suddenly collects into a vivid oval mass, about 6° in length and 4° in breadth, so exceedingly rich in stars that a moderate calculation gives upwards of 100,000. On the other hand, spaces occur in the very middle of its course, which appear, to the naked eye, entirely devoid of stars, and perfectly black. The most remarkable of these is situated in the Southern Cross, where the Milky Way approaches the nearest to the south pole, and so striking is its appearance that the early navigators designated it by the name of the *coal sack*. This space is of an irregular pear-shaped form; it is about 8° in length and 5° in breadth; and was described and figured by the Abbé Feuillée in 1710. Lacaille correctly attributed its striking blackness to the effect of contrast with the luminosity of the Milky Way, which surrounds it on all sides, and which in this region is remarkably brilliant.

It is to be remarked that the great increase in the number of stars which is observed in the neighbourhood of the galaxy is occasioned chiefly by the greater abundance of telescopic stars, that is to say, of those beyond the sixth order of magnitude. Stars of the first magnitude are distributed over the sphere with tolerable uniformity. If, however, we take the whole number visible to the naked eye, a rapid increase is perceptible as we approach the limits of the galaxy; but, with respect to those of the smaller magnitudes, and particularly beyond the eleventh, the accumulation along that circle and its branches almost exceeds imagination. The vast predominance of the small stars must be held to indicate the immense distances at which they are situated.

From the relatively greater abundance of stars in the plane of the Galactic Circle than in the regions on either side of it, and from the indication of some preponderance on the southern side, Sir W. Herschel drew the conclusion that the galaxy is composed of a stratum of stars of which the thickness is inconsiderable in comparison with its length and breadth, and that the sun is placed not far from the middle of the stratum, somewhat nearer to its northern than to its southern surface, and near the point where it subdivides into two principal laminæ inclined at a small angle to each other. Assuming the real magnitudes of stars to be the same, on the average, through the whole sidereal system, he determined by a series of photometrical experiments that stars of the sixth magnitude (the least visible to the naked eye) are twelve times more remote than those of the first, and that the penetrating power of his twenty-foot telescope was seventy-five times greater than that of the naked eye, so that the smallest stars visible in the telescope are at a distance equal to 900 times the distance of Sirius. Now, as the average apparent breadth of the Milky Way is about 5°, its thickness at that great distance must be $900 \times \sin 5°$, or equal to seventy-eight times the distance of Sirius, or more than six times the distance of the stars of the sixth magnitude. Therefore the Milky Way, even in the direction of its poles, extends to three times the distance of the smallest stars visible to the unaided eye, the sun being supposed at the centre of the stratum. Hence it follows that not only our solar system, but all the stars in the firmament visible to the naked eye, are plunged to a great depth in the stratum of stars composing the galaxy, and form an integral part of it.

It must be kept in mind that the above conclusions are based on two hypotheses which are, at best, very precarious; and in fact both of them appear to have been abandoned by Sir W. Herschel himself in his later years. With respect to the first, namely, the distribution of the stars in space at nearly equal distances from each other, he remarks, in a paper pub-

lished in 1817, that although a greater number of stars in the field of view may be taken in general as an indication of their extension to a greater distance, yet the gauges have in reality more direct reference to the condensation than to the distance, and hence a greater number in the field of view may be explained as well by a greater condensation of the galaxy as by a greater extension of its figure in the direction in which the stars appear most numerous. The other hypothesis, namely, that the telescope penetrates to the extreme boundaries of the galaxy, is subject to much doubt. Sir W. Herschel, speaking in 1818 of his forty-foot telescope, the penetrating power of which he estimated to reach to 2,300 times the distance of Sirius, states, as his opinion, that even at this enormous distance the limit of the stratum was not attained, inasmuch as the telescope failed to resolve the nebulous appearance into stars, and he therefore concluded the stratum to be fathomless. Sir John Herschel thinks the limit has been attained only in certain directions: 'Throughout by far the largest portion of the extent of the Milky Way in both hemispheres, the general blackness of the ground of the heavens on which its stars are projected, and the absence of that innumerable multitude and excessive crowding of the smallest visible magnitudes, and of the glare produced by the aggregate of multitudes too small to affect the eye singly, which the contrary supposition would appear to necessitate, must, we think, be considered unequivocal indications that its dimensions, *in directions where these conditions obtain*, are not only not infinite, but that the space-penetrating power of our telescopes suffices fairly to pierce through it and beyond it.' But, on the other hand, there are parts where not the slightest indication of a limit is discernible. 'Such is, in effect, the spectacle afforded by a very large portion of the Milky Way in that interesting region near the point of its bifurcation in Scorpio, where, through the hollows and deep recesses of its complicated structure, we behold what has all the appearance of a wide and indefinitely prolonged area, strewed over with discontinuous masses and clouds of stars, which the telescope at last refuses to analyse.'

There is also another objection which has been raised by Struve, namely that the celestial spaces are not perfectly transparent, and that therefore the light of distant stars is enfeebled more than in proportion to their distance.

The only conclusions which can be safely drawn are the following:—

1. That the whole light of the Milky Way is nothing but the light of innumerable stars of all magnitudes down to the faintest point perceptible in the best telescopes.

2. That the phenomena, on the whole, agree with the supposition that the stars of our firmament, instead of being scattered through space indifferently in all directions, form a stratum of which the thickness is small in comparison with its length and breadth, and that the sun occupies a place near the middle of the thickness, and near the point where the stratum is subdivided into two principal laminæ.

3. That if all the fixed stars in the firmament be regarded as forming one great system—that of the galaxy—we are still in complete ignorance of its extent, and without the least idea of what may be called its ground plan.

Galbanum (Lat.; Gr. χαλβάνη). A slightly fetid gum resin, produced by the *Galbanum officinale*. It is imported from Turkey and the East Indies for medical use, but is of little importance.

Galbula (Lat. *the yellow bird*). A genus of Scansorial birds closely allied to the kingfishers by their elongated sharp-pointed beak, the upper ridge of which is angular; and by their short feet, the anterior toes of which are almost wholly united: these toes, however, are not precisely the same as those of the kingfishers. The plumage of the species of *Galbula* which are called by the French *jacamars*, is not so smooth as that of the kingfishers, and always has a metallic lustre. They are solitary birds, that live in wet forests, feed on insects, and build on low bushes.

Galbulus. In Botany, a term invented by Gærtner, to denote a form of fruit similar to a cone, excepting that the galbulus is round, and has the heads of the carpels much enlarged, as in the fruit of the juniper.

Gale. The *Myrica Gale*, a small native fragrant bush, of the order *Myricaceæ*, found in boggy places.

Gale of Wind. The Sea term for a continued storm of wind: the lowest degree is the *fresh* gale, the next a *strong* gale, and the last a *heavy* or *hard* gale, called also a *whole* gale.

Galea (Lat.). In Antiquity, the headpiece or helmet used in battle by the Roman soldiers. The *galea* was used for the same defensive purposes as the *cassis*; but differed from it in this, that while the cassis was the term properly applied to helmets made of *metal*, the galea was originally of *hides*.

Galea (Lat.). In Botany, the helmet or arched part of a flower, as seen in the Aconite; hence *galeate*, helmeted.

Galega (Gr. γάλα, because it is supposed to increase the milk of animals, especially of goats). The name of a genus of plants, including *G. officinalis*, or Goat's Rue, a plant of little taste, and eaten in Italy in salads. It was formerly held in some repute as a cordial in fevers. The genus consists of perennial herbs of the Leguminous family, nearly related to *Glycyrrhiza*.

Galena (Lat.). Native sulphide of lead, composed, when pure, of 86·6 per cent. of lead and 13·4 sulphur. It forms bunches and veins in igneous and sedimentary rocks, especially in Carboniferous Limestone, in which it often fills irregular cavities and fissures. It occurs in amorphous masses with a lamellar structure, frequently granular, especially when silver is present, sometimes almost compact, and crystallised in cubes, octahedrons, or their modifications. The colour is lead-grey, much like

that of the metal lead, with a metallic lustre, and sometimes superficially covered with an iridescent tarnish. Galena is the most abundant ore of lead, and that from which the greater part of the metal is obtained.

Sometimes Galena is so rich in silver as to be worked almost entirely as an ore of that metal, as is the case at the mines of Saxony, the Harz, and those of Bleyberg in the Eifel.

The largest lead mine in the world is that of Allenheads in Northumberland; and some of the purest metal is that produced at the Austrian mines of Nötsch in Carinthia.

Galenists. In Ecclesiastical History, a subdivision of the sect called Waterlandians in the seventeenth century. In Medical History, the followers of Galen were so termed, in opposition to the practitioners of the chemical school.

Galeopithecus (Gr. γαλῆ, *a weasel*; πίθηκος, *an ape*). A genus of Insectivorous Mammalia, having the bones of the arm and leg, but not those of the digits, excessively elongated, and supporting extensive lateral folds of skin which are useful as a parachute, but not as organs of flight. The species are restricted to the great islands of the Indian Archipelago; their inferior incisors are remarkable for their complex form like the teeth of a comb.

Galeruca (Lat. galerus, *a cap or tuft*). A genus of Tetramerous Coleoptera, now the type of an extensive family (*Galerucidæ*), including amongst other subgenera the noxious turnip-flies (*Haltica*). All the *Galerucidæ* are vegetable feeders, both in their larva and in their perfect state. There are about a dozen known British species of *Galeruca* proper, which are small, and generally dark or dull-coloured beetles.

Galiaceæ (Galium, one of the genera). A natural order of herbaceous Exogens of the Cinchonal alliance, inhabiting the cooler parts of the world. They are distinguished from *Cinchonaceæ* by their square stems and verticillate leaves without stipules. The roots of *Rubia tinctoria* yield Madder, and those of *R. cordifolia* furnish the Munjeet dye of India.

Galipea (the Guiana name). The genus of *Rutaceæ* yields the Angostura Bark of the Pharmacopœia. It is said to be produced both by *G. officinalis* and *G. Cusparia*, and hence is sometimes called Cusparia Bark. It is employed in medical practice as a tonic, and by the natives of Guiana to stupefy fish.

Galipot. A white resin derived from the *Pinus maritima*.

Galium (Gr. γάλα, *milk*). A genus of scrambling herbs, with stellately whorled leaves, small flowers often inconspicuous, and fruits consisting of two dry seed-vessels, each containing a single seed. *G. Aparine*, the Cleavers or Goosegrass, is a common weed in almost every hedgebank, and is remarkable for its globular fruits being covered with hooked prickles. The torrefied seeds are said to be a good substitute for coffee, and the flowers of *Galium verum* are used to curdle milk. The roots of some of them afford a purple dye. Like Madder, they belong to the order *Galiaceæ*.

Gall (Gr. χολή). [Bile.]

Gall of Glass. The salts and other impurities which float upon the fused materials for the manufacture of glass, and which are skimmed off. They are also called *sandiver*.

Gall Insects. The name of a family of Hemipterans, comprehending those of which the females, towards the period of oviposition, assume a globular form, analogous to the galls caused by the *gallicolæ*.

Gall Nuts. Excrescences produced by the *cynips*, a small insect which deposits its eggs in the tender shoots of the *Quercus infectoria*, a species of oak abundant in Asia Minor. When the maggot is hatched, it produces a morbid excrescence of the surrounding parts, and ultimately eats its way out of the nidus thus formed. The best galls are imported from Aleppo and Smyrna; their principal ingredients are tan and gallic acid. The infusion of galls affords a dense white precipitate in solution of gelatine, and a black precipitate with the persalts of iron. The latter property leads to the use of galls in the manufacture of ink and of black dye; they are also used as an astringent in medicine.

Galls. Local affections or diseases of plants, caused by the puncture of insects. They are produced by an excessive deposition of cellular tissue, and are of no consequence to the general health of the individual subject to them.

Gall-bladder. An oblong membranous receptacle attached to the under part of the liver. It retains the bile which regurgitates from the hepatic duct, and sends it through the cystic duct, which proceeds from its neck into the *ductus communis choledochus*, and thence into the duodenum.

Gall-stones. Concretions occasionally found in the gall-bladder and biliary ducts. They consist either of a peculiar fatty matter called *cholesterine*, or of inspissated bile, or of mixtures of the two. The gall-stones of the ox generally contain a peculiar yellow colouring matter which is valued by painters.

Galleon (Ital. galeone). A name formerly applied to large and lofty ships of war: it was subsequently limited to the treasure ships which brought the riches of the New World to Spain. They were heavy unmanageable vessels.

Gallery (Ital. galleria, Fr. galerie). In the Fine Arts, a term applied to a collection of works in painting or sculpture, or to the building containing it. The earliest gallery or museum of which there is any record was that of the Heræum or temple of Juno at Samos, to which a picture gallery (πινακοθήκη) was attached. The Pœcile, or painted chamber, at Athens was a gallery of paintings, but not quite in the sense now applied. The Egyptian Ptolemies formed collections of pictures, as did also the Romans: Verres had a remarkable collection of works of art; and most of the public temples of Rome were depositories of works of painting and sculpture; the Temple of Peace

was renowned for its collections. Constantinople, however, had still greater accumulations than Rome. In Europe, the magnificent Museum of the Louvre, though much reduced in 1815 by the restoration of many works acquired by conquest, is still one of the richest in pictures numerically; but it does not possess so many first-rate Italian pictures as the British National Gallery. The gallery founded at Florence by Cosmo II. long enjoyed the first rank, but must be now considered secondary to several European galleries. The treasures of Florence are, however, divided into two collections—that of the Uffizi, and that of the Pitti palace; but both galleries combined do not equal in numbers the collections of Dresden, of Madrid, or of the Louvre. Numbers, of course, are not the real test of the value of a gallery of works of art; but where all have been formed with more or less indiscrimination, it becomes a fair test. The selected galleries are few, those of the Vatican at Rome, the National Gallery in London, and the Pinacothek at Munich being almost the only examples. If we rank the principal galleries of Europe according to their numbers, the following is their order at this date (1865): 1. Versailles, about 3,300 works, chiefly French battles; 2. Dresden, about 2,200 pictures; 3. Madrid, Real Museo of the Prado, 1,833; 4. The Museum of the Louvre, about 1,800; 5. The Hermitage at St. Petersburg, 1,631; 6. The Gallery of Berlin, 1,250; 7. The Belvidere at Vienna, upwards of 1,550; 8. The Pinacothek of Munich, 1,270; 9. The Gallery of the Uffizi at Florence, upwards of 1,200; 10. The National Gallery, London, about 750; 11. The Gallery of the Museo Borbonico at Naples, about 700; 12. The Academy at Venice, 688; 13. The Academy of Antwerp, 584; 14. The Gallery of Turin, 569; 15. The Brera of Milan, 503; 16. The Pitti Palace, Florence, 500; 17. The collection of Brussels, 400; 18. The Gallery of Amsterdam, 386; 19. The Städel Institution at Frankfort, 380; 20. The Museum at the Hague, 304; 21. The collection of the Academy of Bologna, 280; 22. The Capitol at Rome, 225; and 23. The celebrated Gallery of the Vatican at Rome, only 37. The National Gallery of London is unfortunately at present divided, from utter insufficiency of space at Trafalgar Square, a part of the national collection being placed at Kensington; if united in one whole and properly displayed, it would appear what it is, not only one of the most select and valuable, but also one of the larger European galleries; and it is yet only in its infancy: it was first opened to the public on May 10, 1824, with 38 pictures, just one more than the Vatican possesses at this day. Edinburgh and Dublin have also now their national galleries, and England possesses also the public collections at Hampton Court and Dulwich, besides the valuable royal gallery at Windsor, and the private galleries of the duke of Sutherland, the marquis of Westminster, the earl of Ellesmere, and others. The Borghese Gallery, a collection of upwards of 500 valuable pictures, and the Esterhazy and Lichtenstein collections at Vienna, are perhaps the best private galleries. The Vatican at Rome and the British Museum possess the largest and most valuable galleries of sculpture.

Gallery. In Fortification, a covered passage, sometimes constructed under the counterscarp and loopholed.

Gallery. In Mining, a passage leading inwards from the entrance of the mine.

Galley (Fr. galère). A low-built vessel propelled by sails and oars, either on a single tier, or on tiers of benches one above the other. The war vessels of antiquity were all galleys. Among the Greeks those chiefly mentioned are the pentecontori, which appear to have had fifty oars disposed in a single tier; and the triremes, vessels with three banks of oars. [Trireme.]

Galleys were likewise employed by the maritime nations of the middle ages in the Mediterranean. Their use in naval war hardly ceased until the end of the seventeenth century; and the Venetian republic, down to the period of its extinction, always maintained a number of war galleys. The Venetian galleys had a single tier only, and all modern galleys followed the same construction. These were formidable vessels in a calm, but unfit for a rough sea. The Venetians had also a large high-pooped sort of galley called *galeazza*, whence the word *galleass* and *galliott* in old English writers.

The name *galley* is also applied to some of the smarter boats of a ship of war, as *the admiral's galley, the captain's galley*. The latter is a handsome and very swift boat, propelled by six alternate oars, handled by a picked crew. The *galley* in a ship is the place where cooking is carried on: it is in the forepart of the vessel, on one of the lower decks.

The punishment of the *galleys*, i.e. the employment of condemned criminals in the toilsome employment of rowing them, is said to have originated under the Greek empire. It was used by all the nations bordering on the Mediterranean. In France, under the old jurisprudence, the punishment of the galleys was the severest of secondary penalties. About the end of the reign of Louis XIV., when galleys themselves began to be disused, the galley slaves were employed in hospitals, public works, &c.; and the name of the punishment was changed by the Constituent Assembly (1798) to *travaux forcés*, compulsory labour, whence the word *forçat* for a criminal so condemned. Under the code of the empire the punishment was accompanied with forfeiture of property, infamy, and branding. By an alteration of the law effected in 1832, the brand was abolished; and the criminals, who had hitherto been intermingled in the three penal fortresses (Toulon, Rochefort, and Brest), were classified. Toulon was appropriated to those condemned for ten years and under; Brest, to those from ten to twenty; Rochefort, to persons condemned for life. The name *bagne*, applied in France to prisons in which those condemned to compulsory labour are confined,

is derived from the famous Bagnio prison at Constantinople, so called on account of some baths situated there. The principal crimes now punished in this manner by the French law are—some acts of violence against the government or public law; coining or forgery; assaults followed by death on legal officers; murder, unless under aggravated circumstances; rape, abduction, burglary, highway robbery, perjury, &c.

GALLEY. In Printing, pieces of thin board or metal of different sizes, with ledges about three-fifths of the height of types, for receiving the matter as it is composed, and for affording a level on which to make it up into pages.

Galli. In Roman Antiquities, priests of Cybele, at Rome. The origin of the word is uncertain, but they are said to have been so called from the river Gallus in Phrygia, whence the worship of the goddess was introduced into Rome B.C. 204. (Liv. xxix. 14.) These priests were always eunuchs (Lucretius ii.); and being chosen from a low class, were, unlike all other priests, allowed to beg on certain days. (Cic. *De Legibus* ii. 9.) In their rites they resembled the CORYBANTES, DACTYLI and CURETES [which see].

Gallic Acid. An acid obtained from galls and some other vegetable astringents. It is white, crystalline, and soluble in water and alcohol. It gives an inky-blue colour with a persalt of iron, but no precipitate with gelatine, which distinguishes it from tannic acid. When heated to about 415°, it is resolved into carbonic acid and *pyrogallic acid*; this latter acid is largely manufactured for the purposes of photography.

Gallican Church. The distinctive title of the Roman Catholic church in France, which maintains a certain degree of independence in respect of the Roman see. The liberties of the Gallican Church, first asserted in the Pragmatic Sanction (1438), were defined and confirmed in the Quatuor Propositiones Cleri Gallicani, promulgated in 1682. The occasion of this declaration was a dispute between Louis XIV. and Pope Innocent XI. concerning the right long practised by the French kings of occupying in their own persons the inferior preferments of a diocese which lapsed during the vacancy of the see. It was then determined by an assembly of the French clergy, that the pope has no temporal, but only spiritual rights, as the vicegerent of Christ: that even these are limited by canons and councils: and that the decrees of the holy see are subject to reversal upon the decision of the clergy in general. (*Declaration of the French Clergy concerning Ecclesiastical Power*, drawn up by the famous Bossuet, bishop of Meaux, in the assembly convoked by Louis XIV. in 1682.) While, however, it asserts this liberty in speculative points, the Gallican church does not differ from the Roman in any points of faith. It has, however, always been the object of the Jesuits, and that large party, both of clergy and laity, who have sided with them, to bring the church in France more closely into submission to the see of Rome. The Jansenists; the great legal body, headed by the parliaments; and many of the leading divines of that church, such as Fleury and Bossuet, were arrayed on the other side: and the struggle continued with more or less vehemence through the eighteenth century. The suppression of the Jesuits appeared for the time to give the victory to the Gallican side. But it may be said to have suffered, in the eyes of the Catholic public in general, a very severe defeat when, in the early part of the Revolution, its leaders sided to a considerable extent with the party of progress, and accepted the 'civil constitution' of the clergy. The period of lowest external power of the church in France was that of the revival of what are commonly called Ultramontane opinions in the church of Rome; those, namely, which exalt most highly the papal power, and are most opposed to the existence of anything approaching to national and independent churches or branches of the church within the communion of Rome. Accordingly, the concordat effected by Napoleon I. with Rome, although it established a church, in the political sense of the word, dependent on the State, yet in no degree tended to reconstitute that Gallican church which the great divines of the age of Louis XIV. had endeavoured, with some success, to build up. Since that time the Ultramontane school appears to have acquired still more decided influence among the clergy of France.

Gallicism. Literally, a phrase or construction peculiar to the French language, but used generally to denote such phrases or modes of speech in English as are formed after the French idiom.

Gallicola (Lat. galla, *a gall*; colo, *I inhabit*). The name of a family of Pupiparous Hymenopterans, including those of which the larvæ inhabit the galls or vegetable excrescences caused by the perforation and oviposition of the parent insect.

Gallinaceans, Gallinaceæ (Lat. gallus, *a cock*). [RASORES.]

Gallinule or **Water-hen.** The type of the subgenus *Gallinula*, now dismembered from the *Fulica* of Linnæus, which term is restricted in modern systems of ornithology to the Coots proper.

Galliott. A strong and cumbrous bluff-bowed vessel used by the Dutch, having a main mast and a mizen mast, usually close aft.

Gallizenite. A mineralogical synonym of *Titanite*.

Gallon (Old Fr. galon). An English measure of capacity. By Act of Parliament the imperial gallon is to contain 10 lbs. avoirdupois of distilled water, weighed at the temperature of 62° of Fahrenheit, the barometer standing at 30 inches. This is equivalent to 277·274 cubic inches. The old English gallon, wine measure, contained 231 cubic inches; beer measure, 282 cubic inches. [MEASURES.]

Gallotannic Acid. The tannic acid, or astringent principle of nut-galls, obtained on

percolating galls with washed ether and evaporating the aqueous portion of the percolate. It forms an insoluble compound with gelatine, the formation of which is the chief feature in the operation of *tanning* hides to form leather. Its combination with iron forms the basis of black writing inks. [TANNIN.]

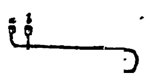
Gallowsbits. On Shipboard, consist of a stout wooden framework for the support of spare spars.

Gally-worm. [JULIS.]

Galt. [GAULT.]

Galvanism (from Galvani, professor of anatomy at Bologna, the discoverer of some of the phenomena connected with this form of electricity in the year 1790). Under this term are frequently included the phenomena of VOLTAIC ELECTRICITY [which see]. We shall here limit it to the apparent evolution of electricity by the contact of different metals; this is best observed by the muscular contractions which are produced in the leg of a frog recently killed, when two different metals, such as zinc and silver, tin and gold, &c., one of which touches the crural nerve, and the other the muscles, are brought into contact. Every time the metals touch each other, the limb becomes powerfully convulsed; and if the experiment be made with a dead rabbit, one of the metals being in contact with the brain, and the other with the muscles of the extremities, the whole body of the animal is strangely agitated. Similar experiments have been made upon the bodies of criminals shortly after execution. These results, which have till lately been considered to depend upon the effects of electricity excited by the contact of the metals upon the nervous and muscular systems, led Volta to his celebrated researches, which terminated in the discovery of the *Voltaic battery*. Nearly all the cases, however, of the apparent production of electricity by contact have been satisfactorily traced by Faraday to chemical action. [VOLTAIC BATTERY.]

Galvanometer. An instrument for ascertaining the presence and estimating the amount of a current of electricity, especially galvanic or



voltaic electricity, by the deviation which it occasions in the magnetic needle. The simplest form of galvanometer is a magnetic needle poised upon a point, and surrounded by one or more coils of copper wire covered with silk, the ends *a* and *b* either being left free, or terminating in two small copper cups containing mercury, for the convenience of communication with the source of electricity. When this needle is placed parallel to the coil, and in the magnetic meridian (as represented in the above figure), it immediately deviates when the electric current passes through the coil; and the deviation is either to the east or the west, according to the direction of the current. [ELECTRO-MAGNETISM.]

Sometimes the needle is surrounded by two separate coils of wire, through which two electric currents can be made to pass in different directions; the deflection of the needle then indicates the comparative strength of the two currents which are tending to deflect it in opposite directions. Such an instrument is termed a *differential galvanometer*. Recently a very sensitive galvanometer has been devised by Prof. William Thompson: it has a small mirror attached vertically to the axis, and upon this mirror a beam of light is thrown, which being received upon a screen at the distance of several feet from the instrument, magnifies any deflection of the needle enormously; since the beam reflected from the mirror not only acts like an arm of the same length, but also travels with twice the angular velocity of the mirror. This form of instrument is termed a *reflecting galvanometer*.

Galvanoscope. An instrument for detecting slight currents of electricity. Its construction is the same as that of the galvanometer; but, being merely a qualitative instrument, it has no provision for measuring the angle of deflection of its magnetic needle. [GALVANOMETER.]

Gamba (Lat.). A technical term in Mammalogy, applied by Illiger to the elongated *metatarsus* of the Ruminants and Solipeds.

Gambeson. [POURPOINT.]

Gambir. An astringent drug obtained from *Uncaria Gambir*, and used as a substitute for Catechu.

Gamboge. A yellow gum resin much used as a pigment, and in medicine as a drastic and nauseating purge. That which is imported from Ceylon in cakes rolled up in flag leaves, is the produce of the *Garcinia Cambogia*. That of Mysore is said to be the produce of *G. pictoria*; while that of Siam has been ascertained to come from a variety of *G. Morella*.

Game Laws. The principal statutes relating to game now in force, are the 7 & 8 Geo. IV. c. 49, the 9 Geo. IV. c. 69, and 1 & 2 Wm. IV. c. 32, with several subsequent statutes amending these enactments. By the common law, which followed the old forest law, as introduced into this country by the Normans, all game was the property of the king; no person whatsoever could enjoy the diversion of sporting, unless authorised by royal grant of a chase or free warren; and to kill a deer was deemed almost as heinous an act as to kill a man. But although at common law no persons could with impunity encroach upon the kingly prerogative of pursuing game, yet those were exposed to the additional pains and penalties of the statute law who committed this offence not being possessed of a certain rank or dignity, or of a certain amount of landed property. Strictly speaking, then, the superior condition in life of a party constituted the ground of his exemption from additional punishment, and not, as commonly supposed, a qualification to do that which was altogether interdicted, whether to the peer or the peasant. But the aggravated offence under the statutes, namely, that of sporting without rank or fortune, being in later times severely

visited, while the original offence at common law was passed over, rank and fortune were, in the end, looked upon as a qualification; and a freehold estate of 100*l.* a year, or leasehold for 99 years of 150*l.* a year, or being the son and heir apparent of an esquire or person of superior degree, were accounted as so many qualifications. The statute law prohibited any persons whatsoever, whether qualified to kill game or not, from making it the subject of sale or merchandise.

The principal alterations in the law made by the last Act above mentioned are, first, that all qualifications are done away with, and that any person taking out a proper certificate may kill game on his own land, or that of another person, with his leave; and secondly, that every person having such a certificate may sell game to any person licensed to deal in it according to the Act, who again is at liberty to retail it without restriction.

Most trespasses and offences relating to game are punishable upon summary conviction, before magistrates. The most serious of these offences is what is called *night poaching*. After two convictions before a magistrate for this offence it becomes a misdemeanour, to be proceeded against by indictment and punishable by penal servitude for seven years, or imprisonment and hard labour. Night poaching committed by three or more persons in company together is a misdemeanour in the first instance, and punishable by penal servitude for fourteen years, or imprisonment and hard labour. By the last 'Act for the Prevention of Poaching,' 25 & 26 Vict. c. 114 (1862), power is given to constables to search for game, without warrant in certain cases, and to detain the game, the party who is found to have unlawfully taken it being liable to fine. For the purposes of this Act, the word *game* is defined to include hares, pheasants, partridges, woodcocks, snipes, rabbits, grouse, black or moor game; besides the eggs of several of these birds.

Games (A.-Sax. gaman, *sport*). Games have been resorted to in all ages and among all nations for the purposes of mental or physical exercise or amusement. The games of the ancient Greeks were religious solemnities, which brought the citizens of all the independent states of Greece in contact; and these festal communions (πανηγύρεις) served as the most popular bonds of social union among all who bore the Hellenic name. The four principal games were the OLYMPIAN, PYTHIAN, NEMEAN, and ISTHMIAN. (Wachsmuth's *Historical Antiquities of the Greeks*, ch. i. part ii. s. 22; Grote's *History of Greece*, part ii. ch. ii. See also the treatise of Barbeyrac on the *Morality of Games*.)

Gaming. In Law, all common gaming-houses are nuisances in the consideration of English law. The first statute against public gaming is the 33 Hen. VIII. c. 9. By 9 Anne c. 14 securities given for the repayment of money lent for purposes of gaming were declared to be void; and any person losing and paying 10*l.* at one sitting might, within three months, recover the same with costs; but the severity of this Act was qualified by a subsequent statute (5 & 6 Wm. IV. c. 41) in favour of innocent holders of such securities. More recently it has been enacted that all agreements by way of gaming or wagering shall be void, and that money, &c., alleged to be won upon any wager shall not be legally recoverable; but this enactment does not apply to any subscription for or towards any plate, prize, or sum of money to be awarded to the winner of a lawful game, pastime, &c. (8 & 9 Vict. c. 109). But gaming as a public offence had never been satisfactorily dealt with until the last-mentioned Act (1846), which gave the power of summary conviction against persons engaged in keeping and managing public gaming-houses, and which was amended and rendered more stringent in 1854 by the stat. 17 & 18 Vict. c. 38. In France, where the privilege of keeping such houses had been farmed by a company for 6,000,000 francs annually, public gaming-houses were suppressed by the law of July 22, 1836, from January 1, 1838; and this example has been followed by most of the chief continental states, so that they now exist only in some small principalities, chiefly German, where the government has not yet been able to make up its mind to the loss of income which their abolition would occasion.

Gamma-function. The name sometimes given to the definite integral

$$\int_0^\infty e^{-x}\,x^{n-1}\,d\,x,$$

for which Legendre in his *Exercices du Calcul Intégral*, vol. ii., used the symbol $\Gamma(n)$, and proposed the name of *second Eulerian integral*, Euler having first examined its properties. These properties are very remarkable, and the more important since a great many definite integrals may be expressed by means of the gamma-function. For positive values of n it can easily be shown, by integrating by parts, that $\Gamma(n+1)=n\,\Gamma(n)$, and since, manifestly, $\Gamma(1)=1$, it follows that for positive integral values of n,

$$\Gamma(n+1)=1\,.\,2\,.\,3\,..\,n=\underline{n}|.$$

When n is a proper fraction, the following relation exists:

$$\Gamma(n)\,.\,\Gamma(1-n)=\frac{}{\sin n\pi}$$

and gives, for $n=\frac{1}{2}$, the value $\Gamma(\frac{1}{2})=\sqrt{\pi}$. It may further be remarked that when $n=1{\cdot}4616321451\ldots$, $\Gamma(n)$ has the *minimum value* 0 8856031944. Legendre, in his *Exercices*, gives a table of the values of $\log\,\Gamma\left(\frac{n}{1000}\right)$ for all integral values of n between 1,000 and 2,000. Gauss, Lagrange, Jacobi, Dirichlet, and several other modern writers have contributed papers on the properties of this important transcendental function.

Gammarines, Gammarina (Gr. κάμμαρος, *a lobster*). The name of a family of

Amphipodous Crustaceans, having the genus *Gammarus*, or the sand-hopper, as the type.

Gammoning. The rope by which the bowsprit is bound firmly down to the cutwater. The object of the gammoning is to exercise a pressure opposite to the upward pressure of the forestays and jibs. The ropes of the gammoning are *frapped* to render them as taut as possible.

Gamomorphism (Gr. γαμέω, *to marry*, and μορφή, *shape*). That stage of developement of organised beings in which the spermatic and germinal elements are formed, matured, and generated, in preparation for another act of fecundation, as the commencement of a new genetic cycle. [PROTOMORPHIC and ORTHOMORPHIC.]

Camut or **Gamma Ut.** In Music, a scale whereon the musical notes are disposed in their several orders. Its invention is attributed to Guido Aretino, a monk of Tuscany; it is also called the *harmonical hand*, Guido having made use of the figure of the hand to demonstrate the progression of his sounds.

Gandharva. [CENTAURS.]

Ganglion (Gr. γάγγλιον, *a knot*). An enlargement in the course of a nerve. A tumour in the sheath of a tendon.

Ganglioneura (Gr. γάγγλιον, and νεῦρον, *a nerve*). A name applied by Rudolphi to the Molluscous and Articulate divisions of the animal kingdom, which are characterised by a ganglionic type of the nervous system. In the articulated gangliated animals the ganglia are always disposed symmetrically along the middle line of the body, and brought into communication by a double chord: these have therefore been termed *Homogangliata*. In the Mollusca, on the contrary, the ganglions are dispersed, and placed at a distance from each other and from the mesial plane, and are frequently unsymmetrical in their arrangement: these have therefore been termed *Heterogangliata*.

Ganglionic Structure (Gr. γάγγλιον). In Anatomy, ganglions are enlargements in the course of nerves resembling knots. Physiologically, the name is applied to collections of vesicular matter which are centres of nervous power to the fibres connected with them. The ganglionic system consists of: 1st, the ganglionic portion of the spinal nerves; 2nd, the internal ganglionic or sympathetic nerves, with their intravertebral connections, or the nerves regulating both the motions of the internal muscular organs, as the heart, stomach, intestines, &c., and the secretions, nutrition, absorption, &c. The ganglionic structure in the brain is frequently termed *grey* matter, as opposed to the *white* matter, or nerve fibres.

Gangrene (Gr. γάγγραινα, from γράω, γραίνω, *to feed upon*, from its eating away the tissues). This term is used to denote a condition of the soft parts of the body closely approaching to death; the term *sphacelus* (Gr. σφάκελος) being more properly applied to absolute death or mortification.

Gangrene may be moist or dry. The former is characterised by the escape of serum into the part, and by extravasation of blood, which coagulates and blackens. Gases are given out, and vesicles containing these gaseous results of decomposition appear on the skin, raising the cuticle; these are called *phlyctænæ*. [PHLYCTÆNA.] Dry gangrene may be regarded as the result of arterial disease. It is generally observed in advanced age, though exceptional cases have been recorded in earlier life. It is best exemplified when gradual ossification of the small arterial trunks occurs; pain, heat, and redness being the first symptoms, after which the parts become gradually black and dry. The hands, forearms, and the feet are chiefly affected. It is this dry form of gangrene which is produced by the ingestion of ergot of rye. [ERGOTISM.]

Gangue. The mineral substances which accompany metallic ores in the veins of rocks.

Gangway. The opening in a ship's bulwarks by which persons are intended to enter the vessel.

Gannet. [PELECANUS and SULA.]

Ganocephala (γάνος, *lustre*, and κεφαλή, *head*). An order of fossil Reptiles distinguished by the sculptured and external polished or *ganoid* bony plates with which the entire head was defended. These include the *post-orbital* and *supertemporal* plates, which roof over the temporal fossæ. There are no occipital condyles. The teeth have converging inflected folds of cement at their basal half. The notochord is persistent; the vertebral arches and peripheral elements are ossified; the pleurapophyses are short and straight. There are pectoral and pelvic limbs, which are natatory and very small; large median and lateral *throat plates*; scales small, narrow, subganoid; traces of branchial arches. The order is found throughout the series of carboniferous rocks; and, so far as present palæontological knowledge extends, the ganocephalous reptiles were amongst the first to appear on our planet. [ARCHEGOSAURUS.]

Ganymedes (Gr. Γανυμήδης). In the Homeric Mythology, a son of Tros and Callirhoë, and brother of Ilus. Being the most beautiful of all mortals, he was taken by Zeus to be his cupbearer and to live among the gods on Olympus. Later writers added that he was borne aloft to heaven on an eagle sent by Zeus.

Gaol (Fr. geole, Ital. gaiola—for gabbiola—*a cage*, from Lat. cavea). A prison. The present law relating to the building, repairing, and maintaining of gaols and houses of correction is regulated by the statutes 4 Geo. IV. c. 64, 5 Geo. IV. c. 12 and c. 85, and 2 & 3 Vict. c. 56 (1839), with several other amending Acts. No gaol can be erected under any less authority than that of an Act of Parliament. There must now be at least one common gaol and one house of correction in every county. Gaolers are appointed by the high sheriff; by 4 Geo. IV. they are forbidden to exercise any other trade or office, and must reside within the prison. As to the discipline and management of gaols, see PRISON. The *commission of gaol delivery*

is one of those held by the judges of the superior courts to enable them to try and discharge prisoners in the gaols of counties which they visit at the ASSIZES [which see].

Gape. In Ornithology, the opening between the mandibles of birds.

Garancine. One of the colouring matters derived from *madder*.

Garcinia (after Dr. Garcia, an Oriental traveller). This genus of *Clusiaceæ* yields the Mangosteen and Gamboge. The plant which produces the Mangosteen is called *G. Mangostana*; and the fruit itself, about the size of an orange, has a thick rind enclosing a juicy pulp having, writes Dr. Abel, 'the whiteness and solubility of snow, and a refreshing delicate delicious flavour' compared to that of a compound of pineapple and peach. Gamboge is the yellow gum resin of *G. Cambogia* and *G. pictoria*, and of a pedicellate-flowered variety of *G. Morella*. It is chiefly imported from Siam by way of Singapore. [GAMBOGE.]

Gardant or Guardant (Fr.). In Heraldry, a term applied to a beast when represented full-faced, as looking at the spectator. *Re-guardant*, when looking backwards.

Garden (Fr. jardin, Goth. gards, Lat. hortus, Gr. χόρτος). A piece of ground, attached to a house, and enclosed, in which are cultivated various vegetables, fruits, and flowers. In the infancy of civilised society, all these were cultivated in one enclosure; but as mankind advanced in civilisation and refinement, and the number of plants to be cultivated increased, it became necessary to adopt separate departments; and culinary vegetables came to be cultivated in the Kitchen garden, fruits in the Orchard, flowers in the Flower garden, ornamental trees and shrubs in the Shrubbery or Pleasure grounds, and timber trees in Plantations, Woods, and Forests. [GARDENING.]

Gardenia (after Dr. Garden of Charleston). This genus of *Cinchonaceæ* will be most familiar to ordinary readers through the Cape Jasmine, as it is called, *G. florida* and *G. radicans*, both beautiful evergreen stove-shrubs with jasmine-scented flowers, of which the double form is that most commonly seen. There are many species known, very varied in character. *G. gummifera* and *G. lucida* of India yield a fragrant resin like Elemi.

Gardening. The art of cultivating a garden comprehends a great variety of objects. [GARDEN.] All these are generally included under the following heads: Horticulture, or the culture of culinary vegetables and fruits; Floriculture, which includes the culture of ornamental and curious flowers, shrubs, and trees; Arboriculture, which implies the culture of trees or shrubs used for various purposes in the arts and in general economy; and Landscape Gardening, or the general disposition of the scenery or landscape about a country residence. [HORTICULTURE; BOTANIC GARDEN; ARBORICULTURE; and LANDSCAPE GARDENING.]

Gargoyle. [GURGOYLE.]

Garlic (A.-Sax. garleac). The bulb of *Allium sativum*, used in cookery, and having what is called the *alliaceous* odour and flavour very strongly developed.

Garlic, Oil of. This oil is obtained on distilling garlic with water. It has a yellow colour and an acrid disagreeable smell and taste. It is the sulphide of the radical *allyl*.

Garnet (Ital. granata, from the resemblance of its red colour to that of pomegranate seeds). A mineral of which there are several varieties. They are all silicates of different bases, which have been divided into the following six subspecies: 1. *Alumina-lime Garnet*, consisting of silicates of alumina and lime, and comprising Cinnamon-stone or Essonite, Grossular or Wiluite, Romanzovite, Topazolite, and Succinite; 2. *Alumina-magnesia Garnet*, composed of silicates of alumina and magnesia; Black Garnet from Arendal; 3. *Alumina-iron Garnet* consisting of silicates of alumina and iron, and comprising Allochroite, Almandine or Precious Garnet, and common Garnet; 4. *Alumina-manganese Garnet*, consisting of silicates of alumina and manganese [SPESSARTINE]; 5. *Iron-lime Garnet*, composed of silicates of iron and lime, and including Aplome, Colophonite, Melanite, and Pyreneite; 6. *Lime and Lime-chrome Garnet* or Ouvarovite, composed of silicates of lime and oxide of chrome.

The Precious Garnet is employed in jewellery, while coarse Garnets are used instead of Emery for cutting gems and polishing metal and stone. [PYROPE.]

Garnishment. In Law, a warning or notice given to a party to appear in court or give information. This technical term is used only in one or two instances. Thus *garnishment* or warning is given to a third person, in whose hands money is attached within the liberties of the city of London by process out of the Sheriffs' Court, who is termed a *garnishee*.

Garotte. [GARROTE.]

Garrison (Mod. Lat. garnitio, *military stores, &c.*; Fr. garnison). A body of forces disposed in a fortress to defend it against the enemy, or to keep in subjection the inhabitants of the town where it is situated. A place where troops are quartered in barracks is called a *garrison*, to distinguish it from a *camp* or *cantonment*.

Garrote or **Garotte.** A mode of capital punishment employed in Spain. The criminal is seated on a stool with his back to a stake. A tight collar is passed round his throat, of which the ends nearly meet; the executioner, standing behind him, twists them closer by means of a screw: the death is instantaneous.

Garryaceæ (Garrya, one of the genera). A small order of diclinous Exogens, typical of the Garryal alliance, and distinguished from *Helwingiaceæ* by the amentaceous flowers and opposite exstipulate leaves. *Garrya elliptica* is an ornamental evergreen shrub.

Garter. In Heraldry, the moiety or half of a bend.

Garter, Order of the. The commonly received story, which attributes the origin of

this illustrious order to the dropping of the countess of Salisbury's garter, is contradicted by many recent writers, who attribute its institution to Richard I., who tied thongs of leather as marks of distinction round the legs of several of his officers at the siege of Acre. In the opinion of Dr. Meyrick (*On Armour*, vol. ii. p. 54), the garter is nothing more than a symbol of unity. The order was, however, either founded or restored by Edward III., and, according to general opinion, either in the year 1344 or 1350. The first of these dates was that of a festival in which the king formed himself and his associates into a company, under the patronage of St. George: but nothing is said respecting the garter until the latter year. The statutes of the Garter have been revived and augmented by Henry V., Henry VIII., and George III in 1805. It was generally called the Order of St. George until the reign of Edward VI.; St. George of Cappadocia, the tutelar saint of England, being likewise patron of this order. It originally consisted of twenty-six knights, the king being the chief; and the same number is still retained, with the addition of princes of the blood-royal as supernumeraries. In the beginning of the present century, it was estimated that eight emperors and twenty-eight foreign kings had been members of it. The number has since been much augmented. It is the most ancient of all the lay orders of chivalry, and may rightly be accounted the noblest in the world. The college of the order is held at the chapel of St. George, in the castle of Windsor. The vestments and ensigns of the order are, the mantle of blue velvet, changed to purple by Queen Elizabeth, but restored to the original colour by Charles I.; the surcoat of crimson velvet; the hood, which is now fixed to the mantle, a cap of black velvet with an aigrette of heron's feathers being worn on the head instead of it; the collar of gold, composed of twenty-six pieces made to resemble garters, with the badge of the order (the figure of St. George and the Dragon) pendent from it; and the garter of blue velvet. The lesser George, as it is called, is attached to a blue ribbon, passing from the left shoulder to the right hip. The officers of the order are: the prelate (the bishop of Winchester for the time being); the chancellor (the bishop of Oxford); the register (the dean of Windsor); garter king-at-arms (this officer combines two functions, being herald to the Order of the Garter, and also principal king-at-arms, the highest officer of the Heralds' College under the earl marshal); and the usher or black rod. It has also a dean and twelve canons, &c., with twenty-six pensioners, or poor knights. The most authentic work on the Order of the Garter is that of the learned antiquary Elias Ashmole.

Gas (probably from the German geist, or *spirit*). This term is applied to all permanently elastic fluids, or airs differing from atmospheric air.

Gas Fittings. The different contrivances for the application of gas lighting, consisting of the pipes and services, the meter, the various burners, such as the batswing, fishtail, cockspur, argand, sun burners, &c. The pipes are either of cast iron, when their dimensions exceed three inches in diameter, or they may be either cast or wrought iron of two inches in diameter: they are made of wrought iron when they are from two inches to half an inch diameter; and of pewter or of tin, when smaller than half an inch, or when let into plastering. In Paris, the service pipes are made almost entirely of lead. Copper pipes must be carefully avoided, as the gas not only corrodes them, but also forms an explosive compound with the copper. The meters may be either the wet or dry gas-meter. Of these, the former are more likely, at first, to mark against the company, and the latter to do so in the course of time. The burners are usually made *batswing* when they have to be exposed to the effects of sudden gusts of wind (as in street lamps, open lights, &c.); the batswing is composed of a nipple, across which a narrow slit is formed, through which the gas escapes in a thin flame; they are made *fishtail* when common gas is burnt without much care, and consist of the nipple pierced with two openings placed so that the jets cross one another; or they are made *cockspur*, which is a simple jet proceeding from the extremity of the nipple. The *argand burner*, of which *Leslie's burner* is an ingenious modification, is a ring pierced with holes, and surrounded with a glass shade, so that the supply of air may be regulated, and the light steadied; the *sun burner* is composed of fishtails, surrounded with a double cone, so contrived that the passage of air shall be uninterrupted round the flame, and a free egress offered to the ventilation. The skill of the gas-fitter must be shown in the adaptation of these various burners to the positions where they may be required; it being observed that they are all adapted to produce their best results when the pressure of the gas is equal to that of a column of water of one inch in height.

Gas Illumination. Under the head of CARBURETTED HYDROGEN we have adverted to two gaseous compounds of hydrogen and carbon which perform an important part in the economy of gas illumination. There are several other analogous compounds, which are produced in various relative proportions during the destructive distillation of pit coal, and which, therefore, are more or less concerned in the history of coal gas, which, as far as gas illumination is in question, may be defined as a mixture of many hydro-carburetted gases and vapours with a considerable volume of other gaseous bodies, among which free hydrogen and carbonic oxide are the most important.

The application of the gases produced from the destructive distillation of pit coal to the purposes of illumination is of modern invention; but the germ of it may be traced back for more than a century. The first authentic record of a permanent elastic and inflammable gas from coal occurs in the

Philosophical Transactions for 1739, in which there is a paper by the Rev. Dr. Clayton, describing the method of filling bladders with what he calls the *spirit of coal*, obtained by distilling coal in a retort upon an open fire. He says: 'I filled a good many bladders therewith, and might have filled an inconceivable number more, for the spirit continued to rise for several hours, and filled the bladders almost as fast as a man could have blown them with his mouth, and yet the quantity of coals distilled was inconsiderable. I kept this spirit in the bladders a considerable time, and endeavoured in several ways to condense it, but in vain; and when I had a mind to divert strangers or friends, I have frequently taken one of these bladders, and pricked a hole therein with a pin, and compressing gently the bladder near the flame of a candle, till it once took fire, it would then continue flaming till all the spirit was compressed out of the bladder; which was the more surprising, because no one could discern any difference in the appearance between these bladders and those that were filled with common air.' Dr. Clayton seems also to have observed those curious phenomena which have since excited so much attention under the terms *exosmose* and *endosmose*; for he goes on to say that he found 'that this spirit must be kept in thick bladders, as in those of an ox or the like; for if I filled calves' bladders therewith, it would lose its inflammability in twenty-four hours, though the bladders became not relaxed at all.'

Dr. Hales (in his *Vegetable Statics*) and Dr. Watson (in his *Chemical Essays*) have each noticed the properties of the gas from coal; but it was not until the end of the last century that the practicability of substituting coal gas in place of other inflammables, for the lighting of streets and buildings, became an object of attention.

The idea of applying coal gas to economical purposes seems first to have occurred to Mr. William Murdoch, of Redruth, in Cornwall, in 1792. His apparatus consisted of an iron retort, and iron and copper tubes, through which the gas was conducted to a considerable distance, and was there, as well as at intermediate points, burnt through apertures of various forms and dimensions; he also washed the gas with water, and used other means for its purification. In 1798 Mr. Murdoch constructed a large and improved apparatus for the purpose of lighting Boulton and Watt's celebrated factory at Soho, near Birmingham, which, on the occasion of the peace in 1802, was publicly illuminated by the same means. ('An Account of the Application of Gas from Coal to Economical Purposes,' by Mr. W. Murdoch, *Phil. Trans.* 1808, p. 214)

But the attention of the public in London was first called to this important subject by the experiments of Mr. Winsor, who in 1803 and 1804 lighted the Lyceum Theatre, and shortly afterwards one side of Pall Mall, with gas from coal. From that period the manufacture of gas suggested itself as a lucrative speculation. Several private gas works were erected, and companies were formed for the purpose of carrying on the manufacture on an extended scale. Oil lamps were soon after banished from all the great thoroughfares of the metropolis; and in the course of from ten to fifteen years not only was every street and alley illuminated from the same source, but it was generally adopted in the theatres and other public buildings; was carried into the suburbs; and has now become general in every town and city of the empire and of the civilised world.

When coal is subjected to destructive distillation, i.e. when it is heated in close vessels, it yields a number of complicated products, which, so far as our present object is concerned, may be classed under three heads, namely: first, permanent gases; secondly, vapours which may be condensed into the liquid or solid state by cooling; thirdly, the fixed or residuary matter, which remains in the retort. The object of gas manufacture is to separate these from each other, and so to purify the gaseous products as to render them fit for combustion.

The apparatus employed for this purpose consists of: first, the *retorts*, as they are called, or cast-iron or fire-clay cylinders, in which the coal is subjected to heat; secondly, the contrivance for condensing the solid and liquid matters; thirdly, the purifiers, by which the gas is cleansed from the various matters which would be prejudicial if retained in it; and fourthly, the gasholders, in which the purified gas is ultimately received, and which are connected with the service pipes for its distribution. The following is a brief description of these several parts; but it is to be observed that gas-making is conducted upon rather different principles in such large towns as London, Paris, &c. from those which prevail in smaller works.

The retorts are of various forms and sizes, but always longer than wide or deep; they differ from about 7 ft. 6 in. long by 20 in. wide and 1 foot deep, to 20 ft. long by 20 in. wide and 13 in. deep, and in some cases they are made of still larger dimensions. They are usually of an arched shape, though sometimes they are perfectly cylindrical; they are of cast iron when in one piece, but when the manufacture is upon a sufficiently large scale to require their being built up of several parts, they are made of fire-clay. Upon the exposed end of the retorts there is placed the mouthpiece, which is of cast iron, and carries the door and ascending pipes, which communicate with the hydraulic main. This is a pipe, usually of cast iron, running along the front of the retort stack, half filled with water, destined to receive a portion of the tar and water passing over with the gas. Thence the gas passes to the condenser, where the tar and remainder of the tar water are deposited. It is to be observed that the quantity of tar will depend much on the temperature at which the distillation has been effected, and great attention is required for this purpose; if it be too high,

the retorts will be burnt out rapidly, and although the quantity of gas will be increased, its quality will be greatly deteriorated; if too low, the quantity of tar will be augmented, and the amount of the gas for illuminating purposes proportionally diminished. From the condensers, the gas passes into the *scrubbers*, where it is exposed to the purifying action of a stream of water passing over layers of coke, and thus deprived of ammonia. It is then conducted to the *purifiers*, where it passes through sieves (charged with hydrate of lime, or with hydrated oxide of iron), which remove sulphuretted hydrogen, and complete the process of purification; the gas is thence conducted through the station meter to the gasholder preparatory to distribution.

In practice, it is found that one ton of coal will yield from 8,000 to 10,000 cubic feet of purified gas, of average illuminating power, leaving a residue of about 15 bushels of coke, and producing about 9 gallons of tar. In London the retorts are charged constantly, so that they work day and night; and some idea of the magnitude of those establishments may be formed when it is stated that in the works of the Imperial Gas Company as much as 250 tons of coal are daily carbonised, and that they have one gasholder capable of containing 1¼ million cubic feet. There are thirteen gas companies in London, which consume about 1,500,000 tons of coal annually. It is calculated that the average consumption of gas by the batswing burners in the street lamps is about five or six feet per hour, and the distance apart of those lamps is about 90 ft. on the same line of footpath; the rate of consumption in private lights, of course, varies very considerably, and no general rule can be laid down respecting it. The law that a light diminishes in intensity as the square of the distance increases, prevails in this case; but in spite of the great waste of gas that it entails, the sun lighting (as the system of concentrating the gas in one centre is called) appears to present such advantages that it is generally adopted in places of public resort.

Gas-meter. Any apparatus used for measuring the volume of gas. The term is, however, usually restricted to an instrument employed in measuring the amount of illuminating gas supplied to consumers. The wet meter was originally invented by the late Mr. Clegg, engineer to the Chartered Gas Works, and has been considerably improved by Mr. Crossley; the dry meter was invented by Mr. John Malam, and has been improved by Mr. Defries. The wet meter consists of a drum, which is made to revolve upon its axis by the ingress and the egress of the gas; this drum works in water, which is regulated so that when the level of it exceeds a certain line, the passage of the gas is intercepted, and when it falls below another line a valve is disengaged that shuts off the entrance of the gas. All that is necessary under these circumstances is to preserve accurately the water-level; and many inventions have been proposed for this purpose, of which Crossley and Goldsmith's patent appears to be the most successful. There is a set of multiplying wheels upon the face, to which the motion of the drum is communicated, and by which the rate of consumption is regulated. The dry gas-meter consists of a vessel in which the gas is introduced into the sides of an apparatus which has a number of diaphragms fixed on the centre or upright division, the other end being loose, so as to be able to expand or contract as the gas fills it; the multiplying wheels are placed in connection with the diaphragms, which work upon the train of wheels by their alternate motion. The great difficulty about these dry gas-meters is to secure the regular passage of the gas through the respective openings, in consequence of the defects in the quality of the leather; if this be effected carefully, and in a lasting manner, there can be no doubt but that the dry gas-meter is superior to the wet one, especially for private consumption, where it is not always possible to secure the care and attention required for the regularity of the water-line. For the purposes of the *station meter*, or that which is used for measuring the quantity of gas made in the factory before it proceeds to the holder, and thence to distribution, there can be no hesitation as to the preference to be accorded to the wet meter. [PHOTOMETRY; RESIDUAL PRODUCTS OF GAS MANUFACTURE.]

Gascoigne's Powder. A compound of absorbent powders with *bezoar*: it was formerly held in great repute as an antidote to poison.

Gases, Diffusion of. If two gases be brought into communication with each other, they will gradually mix or diffuse through each other, although their mingling may have to take place in opposition to gravity. Thus, if a bottle of carbonic acid be connected, even by a narrow tube, with a bottle of hydrogen placed vertically above it, some of the heavy carbonic acid will gradually make its way into the upper bottle, whilst a corresponding volume of the light hydrogen will descend into the lower one. In a few days the two gases will be found completely mixed. The same effect takes place if the gases be divided by a porous diaphragm, such as a plate of gypsum or artificial graphite. It is this property of diffusion which preserves a nearly constant composition in our atmosphere at all accessible heights and over the whole surface of the globe. The chief constituents of the air, differing as they do in specific gravity, could not maintain this constant mixture without diffusion, but would form separate layers floating one above the other. Graham has investigated this phenomenon; and has established the law, that the relative diffusibilities of different gases are inversely as the square roots of their specific gravities.

The following table exhibits, in a condensed form, the results of Mr. Graham's experiments, which are given in the last column, compared with the numbers calculated from $\frac{1}{\sqrt{\text{sp. gr.}}}$:—

Name of Gas	Sp. gr.	Sq. root of sp. gr.	$\frac{1}{\sqrt{sp.gr.}}$	Velocity of Diffusion Air = 1
Hydrogen	·06926	·2632	3·7794	3·83
Marsh Gas . . .	·559	·7476	1·3375	1·344
Steam	·6235	·7896	1·2664	
Carbonic Oxide . .	·9678	·9837	1·0165	1·0149
Nitrogen	·9713	·9856	1·0147	1·0143
Olefiant Gas . . .	·978	·9889	1·0112	1·0191
Nitric Oxide . . .	1·039	1·0196	·9808	
Oxygen	1·1056	1·0515	·9510	·9487
Sulphuretted Hydrogen . . .	1·1912	1·0914	·9162	·95
Nitrous Oxide . .	1·527	1·2357	·8092	·82
Carbonic Acid . .	1·529	1·2365	·8087	·812
Sulphurous Acid .	2·247	1·4991	·6671	·68

Gases, Effusion of. A term used to signify the passage of a gas into a vacuum, through a fine and infinitely short tube; for instance, through a minute aperture in a thin plate of metal. Graham has proved that the velocity of effusion is the same as that of diffusion; or, in other words, gases flow into a vacuum at rates inversely proportional to the square roots of their specific gravities.

Gases, Liquefaction of. The solid, liquid, and gaseous conditions of a body obviously depend upon temperature and pressure. At the ordinary atmospheric pressure, water, for instance, is a solid at temperatures below 32°; a liquid at temperatures between 32° and 212°; and a gas at all higher temperatures. If this gas be cooled, it first liquefies and then solidifies. All gases if sufficiently cooled and pressed would probably become liquids and solids. Many of the gases which are permanent at ordinary atmospheric pressure and temperature, become liquids on increasing the pressure and diminishing the temperature, and some even solidify when cooled sufficiently. Thus sulphurous acid gas liquefies even at 32° if the pressure be increased by half an atmosphere; at − 105° it is solid. Carbonic acid liquefies at a pressure of thirty-eight atmospheres, and at − 70° is a solid. So cyanogen, hydriodic acid, ammonia, sulphuretted hydrogen, nitrous oxide, euchlorine, hydrobromic acid, fluoride of silicon, chlorine, arseniuretted hydrogen, olefiant gas, ethyl, fluoride of boron, and hydrochloric acid gases can be liquefied. But hydrogen, nitrogen, carbonic oxide and nitric oxide resist liquefaction at the enormous pressure of 800, and the first two even at 1,500, atmospheres, the temperature being low at the same time.

Gases, Transpiration of. The passage of gases through capillary tubes is denoted by this term. The rates at which various gases flow through such tubes has been investigated by Graham, who arrived at the following results:—

1. The velocity of transpiration of any gas increases, cæteris paribus, directly as the pressure.

2. The diameter of the tube remaining constant, the volume of gas transpired in equal times is inversely as the length of the tube.

3. Any rise of temperature renders the rate of transpiration slower.

4. The rate of transpiration is independent of the nature of the material composing the tube.

5. Equal weights of oxygen, nitrogen, air, and carbonic oxide are transpired in equal times.

6. The velocities of transpiration of nitrogen, nitric oxide, and carbonic oxide are equal.

7. The transpiration velocities of hydrochloric acid, carbonic acid and nitrous oxide are equal; as are also those of hydrogen and vapour of ether.

Gasholder. A hollow cylindrical vessel open at bottom and closed at top, suspended by counterpoises in a tank of water, so that it may be filled with gas introduced by a central pipe, and the gas afterwards distributed by proper pressure through the mains which convey it for service. Some of these magazines of coal-gas are of an enormous size, holding a million cubic feet and upwards.

Gasket. A plaited cord, by which the sails when furled are kept bound up close to the yards or gaffs. The same term is applied to the plaited hemp used for packing the piston of the steam engine and its pumps.

Gasometer. This term is often applied to the gasholders of coal-gas works; but it is more properly limited to a smaller instrument, constructed upon more delicate principles, and capable of accurately measuring the quantity of gas of any kind which passes into and out of it. These instruments are sometimes constructed of glass and iron, for the purpose of containing mercury, so as to be used for gases which are absorbable by water.

Gasometric Analysis. *Eudiometry*, or the process of separating and estimating the individual constituents of a gaseous mixture. Such an estimation is effected either by the action of absorbents on small volumes of the gas contained in graduated tubes called *eudiometers*; or by exploding the gas with oxygen, and noticing the volumes before and after explosion.

The explosion of combustible gases mixed with oxygen is effected by an electric spark caused to pass through them between the ends of two platinum wires fused into the sides of the eudiometer. The actual operations of transferring, mixing, measuring, exploding and absorbing gases have been greatly facilitated of late years by the labours of Bunsen, Regnault and others. (See article 'Analysis Volumetric of Gases.' in Watt's *Dictionary of Chemistry*.) Much inconvenience and labour of calculation are also now avoided, and greater rapidity of manipulation and accuracy of result obtained, by performing the analysis at one constant temperature.

Gasteropods, Gasteropoda (Gr. γαστήρ, *the belly*, and πούς, *foot*). The name of a class of Molluscous animals, comprehending those which have a ventral muscular disc of greater or less extent, adapted for creeping. The class is divided, according to the modifications of the breathing organs, into the orders *Pulmonata*, *Nudibranchiata*, *Inferobranchiata*, *Tectibranchiata*, *Pectinibranchiata*, *Tubulibranchiata*,

Scutibranchiata, and *Cyclobranchiata*. The *Carinaria*, in which the ventral foot is reduced to a rudimental compressed plate, forms the type of an aberrant group or order, called *Heteropoda*. The pulmonated snail or slug may be regarded as types of the Gasteropodous Molluscs.

Gastornis (from Gaston Plante, the discoverer, and ὄρνις, bird). A genus of fossil birds which has been found in the conglomerate and plastic clay at the base of the Eocene Tertiaries, at Meudon, near Paris. The leg and thigh bones, which alone are known, indicate a species as large as an ostrich, but more robust, and with affinities to wading and aquatic birds.

Gastræum (Gr. γαστήρ). A term in Zoology, applied to the whole of the prone or under surface of an animal's body.

Gastric Juice. The peculiar fluid secreted by the stomach, and essential to the process of *digestion*. When collected from the stomach of an animal killed while fasting, it is transparent and saline, but during digestion it is distinctly acid: and Dr. Prout found that the free acid which it contains is the hydrochloric. One of the most characteristic properties of the gastric juice is its solvent power over the varieties of animal fibre, or albumen, and the facility with which it coagulates milk, and then dissolves the coagulum. [DIGESTION; PEPSINE.]

Gastriloquus. [VENTRILOQUIST.]

Gastritis. Inflammation of the stomach. It is attended by great irritability of the stomach, indicated by hiccup, vomiting, and much pain and general uneasiness; the pulse is small and hard, and there is fever, attended by prostration of strength. It is a very dangerous disease, and requires prompt treatment; especially bleeding, general and local; blisters; hot bath, or fomentation. The constant sickness generally prevents the exhibition of any of the ordinary remedies. When it arises from poison, the stomach-pump and other distinct treatment is often requisite. Idiopathic gastritis is scarcely recognised by the medical profession; the inflammation observed being always traceable to gout, or to the ingestion of irritating liquids or substances.

Gastrochæna (Gr. γαστήρ, and χαίνω, *I gape*). A genus of Bivalve Molluscs, in which a large hiatus or gape intervenes between the closed valves on the ventral aspect of the animal. The mantle is perforated, opposite to this gape, by a small aperture for the passage of the foot; and is prolonged posteriorly into two muscular tubes or siphons. The Gastrochenes inhabit burrows, which they make in the substance of madrepores or calcareous rocks, lining their perforations with a calcareous tube.

Gastrocnemius (Gr. γαστροκνήμιον, *the calf of the leg*). The muscle which principally forms the calf of the leg.

Gastrodynia (Gr. γαστήρ, and ὀδύνη, *pain*). A painful affection of the stomach, often attendant upon dyspepsia.

Gastrolobium (Gr γαστήρ, *a belly*, and λοβός, *a pod*). Like the allied *Gompholobia*, this beautiful genus of Leguminous Australian bushes is most destructive to sheep and cattle. In the western settlements, along with their near allies just mentioned, the species are known as Poison-plants. *G. bilobum*, *grandiflorum*, and *spinosum* appear to be amongst the most virulent of the species. Death is speedy and certain after browsing on the foliage, and large numbers of animals are annually lost in this way.

Gastromancy (Gr. γαστήρ, and μαντεία, *prophecy*). A kind of divination practised among the ancients by means of words supposed to issue from the belly.

Gastronomy (Gr. γαστρονομία). The so-called science of eating and drinking. [FOOD.]

Gastroraphy (Gr. γαστήρ, and ῥάπτω, *I sew*). In Surgery, the operation of sewing up wounds of the abdomen.

Gastrotomy (Gr. γαστήρ, and τέμνω, *I cut*). The operation of cutting into the abdomen.

Gathering. In Printing, making up the sheets, after they are printed, into a complete set ready for the bookbinder.

Gauge Point. A term used in Gauging, to denote the diameter of a cylinder whose altitude is one inch, and its content equal to that of a unit of a given measure. For example, the old wine gallon contained 231 cubic inches. The diameter of a cylinder of the same capacity, and whose altitude is one inch, is 17·15 inches; which, therefore, is the gauge point for this measure.

Gauges, Steam and Water (Fr. jauge). The apparatuses fixed to every well-built boiler for ascertaining the force of steam and the level of the water. The first consists of a siphon tube containing mercury in the case of low-pressure engines, and of a spiral spring attached to a wheel indicator in the case of high-pressure engines. The last consists of a vertical glass tube or flat case communicating, above and below, with the boiler. Gauge cocks are sometimes put instead of, or in addition to, the tubes for the purpose of enabling the engineer to verify the water-level.

Gauging. In Astronomy, a process devised by Sir W. Herschel for counting the stars. It consisted in numbering those of all magnitudes which occurred in single fields of view of 15 inches diameter, visible through his reflector of 18 inches aperture, and 20 feet focal length, with a magnifying power of 180.

GAUGING. In Mensuration, the measuring of the capacities of vessels, chiefly casks, barrels, vats, &c. The principles of gauging are those which geometry furnishes for the measurement of solids in general. (Symon's *Practical Gauger*; Leadbetter's *Treatise on Gauging*; Hutton's *Mensuration*, &c.)

Gauging Rule. [SLIDING RULE.]

Gault. The name locally given to a division of the upper cretaceous rocks in England. It is a provincial term. The rocks so called are chiefly developed near Folkestone and in Cambridgeshire.

Gault is understood to mean a peculiar brick clay of a blue colour, having occasional calcareous concretions, and certain characteristic fossils, among which are bones of a bird. Beds of the same age occur as compact sandstones in the Blackdown Hills, Devonshire, and are there worked for building purposes. These beds are also rich in fossils.

The gault lies between the lower and the upper greensand. It is represented in Germany by the *Lower Pläner* of the north of Germany, a rock often containing hippurites. [HIPPURITE.] A remarkable schistose bed in the canton of Glarus in Switzerland, celebrated for its fossil fishes, is of this period. In France there is a bed, argillaceous like the gault, cropping out below beds which represent the upper greensand, at Mons in the valley of the Loire.

Gaultheria (after Dr. Gaulthier). Under the names Partridge-berry, Deer-berry, Tea-berry, Box-berry, &c., are known the fruits of *G. procumbens*, which afford winter food for partridges, deer, and other wild animals. The plant is called Wintergreen in North America, and has a peculiar aromatic odour and flavour, due to the presence of a volatile oil, obtained by distillation, and known as Wintergreen oil. The plant is also called Mountain Tea, and its leaves are used as a substitute for genuine tea. *G. Shallon* produces dark purple berries, which form excellent tarts.

Gauntlet, Running the. A barbarous punishment formerly enforced in the navy, by which the criminal was obliged to pass between the seamen arranged in two rows, and provided with knotted cords, with which they flogged him.

Gauntlets (Fr. gantelet). Gloves of armour, originally formed of chain mail, later of plate, and articulated at the fingers. A gauntlet was thrown down to challenge an adversary, who, by taking it up, accepted the challenge. It was till recently the custom at the coronation of a sovereign in this country for the hereditary champion of England to throw down a gauntlet in Westminster Hall, and challenge all disputants of the crown. [CHAMPION.]

Gauze (Fr. gaze). A textile fabric generally made of silk, and said to have been invented in Gaza, a city of Palestine.

Gavelkind (A.-Sax.). An old English custom or tenure annexed to all lands in the county of Kent not especially exempted, by which the land of the father is equally divided at his death among all his sons, or the land of the brother among all his brethren if he have no issue of his own. Tenure in gavelkind is considered by Blackstone to have been in the nature of free socage. In most places the gavelkind tenant had the power of devising by will before the Statute of Wills. The same custom seems to have been prevalent in Wales, where all gavelkind lands were made descendible to the heir at common law by stat. 34 & 35 Hen. VIII. c. 36. In Kent the lands have been in particular cases disgavelled, or deprived of their customary descendible quality, by statute, but all land in Kent is primâ facie gavelkind.

Gavial. [CROCODILE.]

Gavot (Fr. gavotte). In Music, an air for a dance, which has two strains; the first having usually four or eight bars, and the second eight or twelve more, each of which are played twice over. It is of a brisk nature.

Gaylussite. A mineral named after Gay Lussac, found at Lagunillâ, near Merida; it is composed of nearly equal weights of carbonate of soda, carbonate of lime, and water.

Gazelle (Fr. from the Arabic al-gazal). The name of a small, swift, and elegantly formed species of Antelope, the *Antilope dorcas* of Linnæus; famed for the lustre and soft expression of its large dark eyes.

Gazette (Fr.; Ital. gazetta). A periodical paper, published at short intervals, containing articles of general intelligence. Both on the Continent and in England such sheets were generally termed *Mercuries* in the first times of their invention, and appeared only occasionally the earliest among ourselves are said to have been published during the general apprehension from the presence of the Spanish armâda; but doubt has been thrown on the authenticity of the specimens preserved in the British Museum. The first gazette produced in France (under that title) was in 1631; the first in England in 1665, when the court resided at Oxford on account of the plague of London. From that period the *Gazette* has appeared regularly twice a week, containing such notifications as are either published by the court or the government, or such as are authoritatively required by law in private transactions. [NEWSPAPER.]

Gazetteer. This term denotes any work containing a brief account of all or any of the countries of the world, arranged in alphabetical order. To this class belong Brookes's *General Gazetteer*, and similar works.

Gazolites. [AËROLITES.]

Gear or **Geer.** In Mechanics, a term applied in mill-work to wheels, or wheels and pinions, acting into each other. *Spur gear* signifies wheels acting together in the same plane, with their axes parallel; for example, the wheel and trundle. *Bevel gear* is applied t[o w]heels acting together whose axes are inclined to each other.

Geckotii. A family of lizards having for its type the genus *Gecko*; in which most of the species present a curious organisation of the foot, by which the sole is converted into a sucker, each toe being converted into a sucking disc, enabling the animal to creep up vertical walls and along ceilings against gravity, like the flies upon which they feed.

Gehenna. This word, meaning in Hebrew the valley of Hinnom, where the Jews burnt their sons and daughters in the fire to Moloch, is in the authorised version of the Scriptures translated by *hell*. By mediæval writers it was used not only in this sense, but generally in that of pain and suffering. Thus was produced the verb gehenner, *to torture*, which has passed into the modern French gêner, *to annoy*. (Max

Müller, *Lectures on Language*, 2nd series, p. 239.)

Gehlenite. A mineral in small grey or yellow crystals, found in the valley of Fassa in the Tyrol, named in honour of Gehlen the chemist. It is a basic silicate of alumina and lime with some iron and magnesia.

Geine (Gr. γήϊνος, *of earth*). The soluble brown matter which may be extracted from soils by the action of water. [Humic Acid.]

Gelalaean Era. The era of Yezdegird, so called from its reform by Gelal-Edin, sultan of Khorassan. [Æra.]

Gelatine (Lat. gelu, *ice*). An abundant proximate principle in animals. It is confined to the solid parts of the body, such as tendons, ligaments, cartilages, and bones, and exists nearly pure in the skin; but it is not contained in any healthy animal fluid. Its leading character is the formation of a tremulous jelly, when its solution in boiling water cools; it may be repeatedly liquefied, and again gelatinised, by the alternate application of heat and cold. Isinglass, glue, and size are various forms of gelatine, the first being this substance in a very pure state. Its most distinctive chemical character is the formation of a dense white precipitate when its solution in warm water is poured into an infusion of galls or other form of vegetable tannin. A solution of one part of gelatine in 5,000 of water is rendered slightly turbid by the addition of a strong tincture of galls. Gelatine is a nutritious article of food. The ultimate components of gelatine are 47·8 carbon, 7·9 hydrogen, 16·9 nitrogen, 27·4 oxygen.

Gelatines (Fr. gelatine). Mr. Kirby thus renders the term *Radiaires molasses* of Lamarck, by which are designated the radiated animals called *Acalephes* by Cuvier: the bodies of these Radiaries are generally of a gelatinous consistency.

Gem (Lat. gemma). In Sculpture, the practice of carving gems is of remote antiquity, though it is doubtful whether the ancients were able to cut the diamond or use the emerald and topaz for sculptural purposes. The stones usually selected are rock crystal of different colours, jasper, chalcedony, onyx, cornelian, and blood stone. Among the Greeks the art was carried to great perfection. Like the other arts, it fell into disuse; but since its revival in Italy in the fifteenth century, modern masters have more than rivalled some of the ancient productions.

Gems, Artificial. These are made of a transparent and dense glass, or *paste*, as it is called, containing a large proportion of oxide of lead, and generally some borax: the colours are given by metallic oxides. Much of their perfection depends upon the skill with which the exact tint of the real stone is imitated, and upon the care with which they are cut and polished. [Glass.]

Gemara. [Talmud.]

Gemini (Lat. *the twins*). The third sign of the zodiac, into which the sun enters about the 21st of May in each year. The constellation of the same name is easily distinguished by means of two conspicuous stars of the second magnitude near together; Castor being farthest to the west, and Pollux farthest to the east. Castor is one of the largest and finest double stars in the northern hemisphere. Its constituent stars form a binary system revolving in about 250 years.

Gemitrices (coined from Lat. gemo, *to moan or coo*). In Ornithology, an order of birds comprising the *Columbinæ* or pigeons.

Gemma (Lat.). In Botany, the name for a leaf-bud.

Gemmation (Lat. gemma). In Botany, the act of budding.

Gemmipara (Lat. gemma, *a bud*, and pario, *I produce*). The animals which propagate by buds, as the *hydra*, or fresh-water polype, &c.

Gemmule (Lat. gemma). In Botany, sometimes applied to the ovule or young seed, and sometimes to the plumule of the perfect seed.

Gena (Lat. *the cheek*). A term applied in Zoology to the region between the eye and the mouth, generally extended over the zygomatic arch.

Gendarmes or **Gens d'Armes** (Fr.). In the fourteenth and fifteenth centuries, the heavy French cavalry, which constituted the only national force, were termed *gens d'armes*, or *hommes d'armes*, men-at-arms. Each lancer had several followers on horseback, attached to him in various capacities; so that a *lance*, in the language of historians of that epoch, comprehends from three to ten men. In course of time the name of gendarmes ceased to be thus applied, and was given to the king's guards. It was afterwards transferred to a corps of police, and is now applied to the ordinary police force of the country, except in Paris, which is under special regulations. The French gendarmerie is composed of six legions, comprising about 15,800 men. (Bouillet, *Dictionnaire Universel.*) In all the German states, there is a body of mounted military police, with this appellation, of which the German equivalent is *Landdragoner*.

Gender (Lat. genus). In Grammar, the designation of sex by the form of a word.

Genealogy (Gr. γενεαλογία, from γενεά, *family*, and λόγος). The pedigree of a family. A series of several persons, descended from a common progenitor, is called a *line*. A direct line is either ascending (father, grandfather, &c.: in the civil law particular names were given to seven degrees in this line) or descending (son, grandson, &c.). The collateral lines comprehend the several lines which unite in a common progenitor; and are either equal or unequal, as the number of degrees in the lines is the same or different. The collateral relations on the father's side are termed in the civil law *cognati*, on the mother's *agnati*.

General. In the Army, this, next to that of field marshal, is the highest military title adopted by the European states. The name designates

his command as having the *general* or highest orders to give in battle. There are a number of general officers in all European armies. In our service there are three ranks, the highest *general*, the second *lieutenant-general*, the junior rank *major-general*. The colonels of regiments are always general officers.

General Assembly of the Church of Scotland. [ASSEMBLY; PRESBYTERIANS.]

General, Brigadier. [BRIGADE.]

Generalisation. In Logic, has been defined as the act of comprehending under a common name several objects agreeing in some point which we abstract from each of them, and which that common term serves to indicate. (Whately's *Logic*, p. 388.)

Generalissimo. A title conferred, especially by the French, on the commander-in-chief of an army consisting of two or more grand divisions, each under the superintendence of a general. According to Balzac, this dignity was first assumed by Cardinal Richelieu on the occasion of his leading the French army into Italy; but the term does not appear to have found favour among the other European states.

Generality. A French territorial division under the government prior to the Revolution. The generalities amounted in all to thirty-four. This division was principally with reference to the collection of taxes.

Generating Function. A name given by Laplace in his *Théorie des Probabilités* to that function which, when developed in a series of powers of its independent variable, *generates* given expressions in the form of coefficients. Thus the generating function of n is $\frac{x}{(1-x)^2}$ since the coefficient of x^n in the expansion of this fraction is n. Generally, if $u_n x^n$ be the general term in the expansion of a function $\phi(x)$, then the latter is said to be the *generating function* of u_n, and the relation between $\phi(x)$ and u_n is expressed by the symbolical equation

$$\phi(x) = G(u_n).$$

Thus, in the above example,

$$\frac{x}{(1-x)^2} = G(n).$$

The theory of generating functions is of importance in the calculus of differences. (Sir J. Herschel's *Examples of the Calculus of Differences*, 1813; and Boole's *Treatise on the Calculus of Differences*, 1860.)

Generator (Lat.). In Geometry, denotes a point, line, or surface by whose motion another curve or surface is or may be conceived to be described or defined. The term is most frequently applied to the right lines on a ruled surface.

Genesis, Book of. [PENTATEUCH.]

Genethliac (Gr. γενεθλίακον, from γενέθλη, *birth*). An ode or other short poem composed in honour of the birth of an individual.

Genethliaci (Lat. from Gr. γενέθλη, *birth*). A name given at Rome to those who professed to predict the future of a man by means of the stars which presided at his nativity. They were also called *Mathematici*, from their use of diagrams like those employed by geometricians.

Genette (Fr.). A small variety of horse. Also an animal of the civet kind (*Viverridæ*), having a musky odour.

Geneva. [GIN.]

Geniculate (Lat. geniculatus; from genu, *the knee*). In Botany, bending abruptly in an obtuse angle, like the knee when a little bent, as in the stems of some grasses.

Genii. Called by the Eastern nations Ginn or djinn, are a race of beings created from fire, endowed with a corporeal form, which they are capable of metamorphosing at pleasure. They are said to have inhabited this earth many ages before the creation of man, and to have been at last driven thence for rebellious conduct against Allah. Their present place of abode is *Ginnistan*, the Persian Elysium; but they are represented as still interesting themselves in the affairs of this earth. A more correct idea may be formed of their origin, characteristics, and history, from a perusal of the *Arabian Nights' Entertainments*, than can be conveyed by the most elaborate dissertation. For an account of the superstitions of the modern Arabs in regard to genii, see Lane's *Modern Egyptians*. [GENIUS.]

Genioglossi (Gr. γένειον, *the chin*, and γλῶσσα, *the tongue*). In Anatomy, a pair of muscles by which the tongue is protruded.

Genipa (genipapo, the Guiana name). The Genipap fruit of South America, as large as an orange and agreeably flavoured, is obtained from a plant of this Cinchonaceous genus called *G. americana*. In Surinam it is known by the name of Marmalade Box.

Genista (Lat. *the broom plant*). A genus of *Leguminosæ*, one of which is the *planta genista* or *plante genêt* of the French, from which the Plantagenets took their name. *G. tinctoria* was formerly of some importance as a dye plant, and was known by the name of Dyer's Greenweed, or Dyer's Broom, the green colour being obtained by dipping the yellow-dyed articles obtained by its agency in a solution of woad. Kendal green was obtained by this process. The common Broom is now, however, generally referred to the genus SAROTHAMNUS.

Genitive Case (Lat. genitivus, *generative*). That inflection of the noun which denotes relation. With Aristotle it was the predicating case, which determined the class or genus to which a thing belonged. As such, it had no reference to origin or birth. The Greek genitive was formed by the same suffix which converted a noun substantive into an adjective. (Max Müller's *Lectures on Language*, first series, p. 104.) [GRAMMAR.]

Genius (Lat.). According to the belief of the old Italian races, especially the Etruscans, the genius was a spiritual agency of very indeterminate character, which seems to have been appropriated not only to every human family, but to every god, and even to places and things. The life of the genius ceased with that of the

person whom he guarded. (Sir G. C. Lewis, *Astronomy of the Ancients*, p. 313.) This conception was altogether foreign to Grecian mythology, although in later times it became mingled in that of Rome with the Grecian notions respecting demons. [DÆMON.] Censorinus (*De Die Natali*) says, 'The genius is that god under whose protection every mortal is born and lives.' Hence the worship of the genius was closely connected with all domestic ceremonies and feelings; the marriage bed was *lectus genialis*; the day of the genius, *genialis dies*, was sacred to mirth and relaxation; the genius accompanied human fortunes in their vicissitudes (Vultu mutabilis, albus et ater—*Hor.*); and death was typified by the figure of a genius with a lamp reversed. The genii of places were usually represented and worshipped under the figure of snakes. Whether there is any connection between the Italic genius and the djinn of Oriental nations [GENII] is a doubtful point.

Gennet, Order of the. The first order of chivalry known in France, founded by Charles Martel after his defeat of the Saracens at Tours in 726. It received its name from the gennet or wood-martin, to commemorate the aid supposed to be given by St. Martin of Tours towards defeating the enemy.

Genouillère (Fr.). In Fortification, the part of the interior slope of the parapet below the sill of an embrasure. It covers the lower part of the gun-carriage. In armour of the fourteenth century, the knee-piece or knee-boss.

Genre (Fr. du genre bas, *of a low kind*). In Painting, a term applied to express a class of pictures which belong to none of the higher or specific classes of art. It refers commonly, as the full French expression implies, to ordinary scenes of vulgar life. Yet a *peintre de genre* or *genre*-painter is not necessarily a painter of low subjects, nor need a *genre* picture be vulgar in the common acceptation of the word. The Dutch are the great *genre* painters; and the style was also known to the ancients. Pyreicus, a famous Greek painter of this class, was called ῥυπαρογράφος, literally *dirt-painter*, or ῥωπογράφος, from ῥῶπος, *common ware* or *trumpery*. He painted barbers' shops, cobblers' stalls, shell-fish, eatables of all sorts, and the like, and his pictures were highly valued. (Pliny xxxv. 37.)

Gens (Lat.). In ancient History, a clan or sect, forming a subdivision of the Roman people next in order to the curia or tribe. The members and houses (*familiæ*) composing one of these clans were not necessarily united by ties of blood, but were originally brought together by a political distribution of the citizens, and bound by religious rites, and a common name, derived generally from some eponymous hero. This common name, which distinguished the *gentiles* or members of the same clan, was the second of the three borne by a Roman citizen, and was specially termed the *nomen*. It is supposed that each of the *curies* originally contained ten *gentes*, and that each of these was represented in the senate by one of its members. (Vico, *Scienza Nuova*; Niebuhr's *History of Rome*; Mommsen's *History of Rome.*)

Gentian (said to be so named after Gentius, an Illyrian king). The Gentian root of the shops is the produce of plants of this genus, and principally of *G. lutea*, but those of *G. purpurea*, *pannonica*, and *punctata* are similarly employed, and indeed all the species are pervaded by a pure bitter principle which renders them valuable as tonics. Some of the species are found on the European Alps near the snowline, and their bold cerulean blossoms are greatly admired.

Gentianaceæ (Gentiana, one of the genera). A natural order of herbaceous Exogens of the Gentianal alliance inhabiting most parts of the world. They are very near to *Apocynaceæ*, from which they differ in their herbaceous habit, permanent corolla, want of milk, and in many other characters. From *Scrophulariaceæ* they are distinguished by their regular flowers, the stamens of which are equal in number to the lobes of the corolla. Their chief sensible property is an intense bitterness, which resides both in the stems and roots.

Gentianic Acid. *Gentianin.* A crystallisable body contained in Gentian root.

Gentile (Lat. gentilis, from gens, *nation*). The original meaning of the Latin word *gentilis* is, one of the *same* kith or nation with the speaker. The Jews designated all who did not profess their religion indiscriminately as *the nations*, τὰ ἔθνη; and hence the Greek word ἐθνικος and the corresponding Latin word *gentile* became used to signify Pagans, in opposition to Christians and Jews. The word *gentilis* is used in this sense by St. Jerome, Prudentius, and Christian writers of that age in general. The jealousy with which the Jews regarded all foreign nations, and the obstinacy with which they clung to the notion of their own peculiar sanctity, are well known. The earlier half of the history of the Acts contains the account of the struggle which Christianity maintained against these prejudices before it finally subdued them. The observance of certain Jewish ceremonies continued, however, for a long time to be a stumbling block to the most devout and sincere Christians. Even in the post-apostolic age, the judaising party formed a distinct division of the Christian world, split itself into various sects, such as the Ebionites and Nicolaitans, and for a long time exercised considerable influence even within the pale of the church.

Gentleman (the English word *gentle* in its original sense signifies one belonging to a *race* or *family*; Lat. gens). In Heraldry, a rank expressed in Latin by the term *generosus*. All entitled to coat-armour are gentlemen; but the name is more commonly applied to the lowest rank of those who have no other distinguishing title. Gentlemen by blood were those who could show four generations of gentlemen, both in the paternal and maternal line. Those who could not prove this, but against whom the contrary was not known within memory of

man, were gentlemen by prescription. Gentlemen were also created by letters patent of the king. Officers (not menial) of the king's household, persons holding a royal commission, civil or military, persons who had taken a degree in the liberal arts, and persons adopted by gentlemen, were considered entitled to this rank, which has now been long obsolete as a distinction.

Gentleman Usher of the Black Rod. An officer belonging to the Garter, whose duty it is to attend the House of Lords during the sessions of parliament, and to carry messages to the House of Commons.

Gentlemen-at-Arms. A corps of forty gentlemen whose duties are to attend the sovereign on state occasions. The corps was established by Henry VIII. in 1509, under the name of '*The Band of Gentlemen Pensioners.*' It consisted entirely of men of noble blood, and was called *His Majesty's Honourable Corps of Gentlemen-at-Arms* by William IV. in 1834, and is now recruited entirely from retired army officers.

Gentles. The maggots or apodal larvæ of the flesh fly (*Musca carnaria*), and other Diptera, are sometimes so called.

Genus (Lat.). In Logic, one of the predicables, which is considered as the material part of the *species* of which it is affirmed. [Logic; Predicable.]

Genus. In Music, the general name for any scale of music. If a scale proceed by tones, it is called the *diatonic* genus; if between the tones semitones are introduced, it is called the *chromatic* genus. When the subdivisions are smaller, as quarter tones, it is called the *enharmonic* genus.

Genus. In Natural History, that distinct but subordinate group of animals and plants which gives its name as a prefix to that of all the species of which it is composed.

Geocentric (Gr. γῆ, *earth*, and κέντρον, *centre*). A term frequently used in Astronomy, signifying literally *having the earth for its centre.* The apparent motion of any planet, as seen from the earth, is called its *geocentric motion.* The *geocentric latitude* of a planet is the angle formed by a straight line, supposed to be drawn from the planet to the earth, with the plane of the earth's orbit or the plane of the ecliptic. *Geocentric longitude* of a planet is the angle at the earth formed by two straight lines, one of which is drawn to the first point of Aries, and the other to that point of the ecliptic which is intersected by a perpendicular circle, the plane of which passes through the earth and planet. *Geocentric* is opposed to *heliocentric*, which refers to the centre of the sun. These terms are used only in speaking of bodies belonging to the solar system. The fixed stars are at such prodigious distances, that they are referred to the same points in space, whether we consider them as seen from the earth or the sun.

Geodes (Gr. γεώδης, *earthy*). Hollow nodules the interior of which is frequently lined with crystals of Quartz, Calc Spar, &c. Bodies of this kind are of frequent occurrence in the New Red Marls of Somersetshire and Gloucestershire, where they commonly go by the name of *Potato-Stones.*

Geodesic Curvature. [Curvature, Geodesic.]

Geodesic Line. In Geometry, a curve traced on a surface, so that its osculating plane at every point contains the normal to the surface at that point. A *geodesic* may also be defined as the curve which a string, lying on the surface, would assume if subjected to tension at its extremities. From this definition it follows that a geodesic must, under ordinary circumstances, be the shortest line that can be drawn on the surface between any two of its points. The geodesics on a sphere are its great circles; the geodesics on a developable surface become, of course, right lines when the surface is unfolded into a plane. The geodesics on an ellipsoid have very beautiful properties; as an example, we may mention the theorem discovered by Prof. Roberts of Dublin (Liouville's *Journal*, vol. ii. 1846), according to which the sum (or difference) of the two geodesics joining any point of a line of curvature to two umbilics is constant. Every surface may be said to have a geometry of its own in which geodesics correspond to right lines on a plane. On the ellipsoid, therefore, the lines of curvature correspond to plane conics. The geodesics on a quadric surface are examined at some length in Salmon's *Analytical Geometry of Three Dimensions*; and interesting general properties of geodesics will be found in Gauss' *Disquisitiones generales circà Superficies Curvas*, as well as in the notes to Liouville's edition of Monge's *Application de l'Analyse à la Géométrie*, in which this memoir of Gauss' is reprinted. The differential equations of a geodesic are easily deduced from the first definition. If $u=0$ be the equation of the surface, and s denote an arc of a geodesic, we have

$$\frac{d\frac{dx}{ds}}{\frac{du}{dx}} = \frac{d\frac{dy}{d}}{\frac{du}{dy}} = \frac{d\frac{dz}{ds}}{\frac{du}{dz}}.$$

Geodesy (Gr. γεωδαισία, from γῆ, and δαίω, *I divide*). This term signifies literally the *division of the earth*, in which sense it is synonymous with land surveying; but it is usually employed in a more general sense to denote that part of practical geometry which has for its object the determination of the magnitude and figure either of the whole earth, or of any given portion of its surface. In this sense it comprehends all the geometrical or trigonometrical operations that are necessary for constructing a map of a country, measuring the lengths of degrees, &c. In order to construct an accurate map, or determine the form and dimensions of a country, it is necessary, in the first place, to determine the absolute distances between the several stations or points; secondly, to determine the azimuths of the lines thus measured, that is

their situation with respect to the meridian; and thirdly, the differences of latitude and longitude of the stations. The operations necessary for determining the absolute distances, comprehending the measurement of a base, the observation of angles, the computation of the sides of the triangles, and their reduction to the same level, are called the *geodesical* or *geodetical* operations; while those which are required for determining azimuths and latitudes are called the *astronomical* operations. The determination of the figure and dimensions of the earth is a problem of very great importance to astronomy and geography, and has accordingly at all times been a subject of much interest to mathematicians; but it is only since the middle of the last century that operations on an adequate scale for its solution have been undertaken in different parts of the world. For the results of the more important of these operations, see DEGREE.

Geognosy. [GEOLOGY.]

Geography (Gr. γεωγραφία, from γῆ, and γράφω, *I describe*). The description of the earth. The subjects comprehended in the science of Geography are usually arranged under three great divisions—ASTRONOMICAL, PHYSICAL, and POLITICAL GEOGRAPHY.

GEOGRAPHY, ASTRONOMICAL.—This division of geography has for its object the determination of the form and dimensions of the earth and its relations with the celestial bodies.

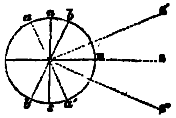
In order to describe the earth, the first point to be ascertained is its general form. That the surface of the earth is convex, is apparent from the phenomena presented by the gradual coming on of day and night, and the deplacement of the stars in proceeding towards the north or south; for if the earth were flat, the sun, in appearing above the horizon, would illumine the whole of its surface at the same instant; and on the supposition of its being either flat or cylindrical, the pole star would maintain the same elevation, whereas to the traveller who advances northward it gradually appears more elevated, and to him who advances southward more depressed. All these appearances are observed in the same manner on whatever part of the earth we are placed; and from them alone the globular form of the earth might be inferred, even if the fact had not been placed beyond doubt by the voyages of circumnavigators. Astronomers in modern times have indeed discovered that it is not a perfect sphere, being flattened in a slight degree at two opposite points (which are the poles of rotation); but the deviation from perfect sphericity is so small, that for all the purposes with which geography is concerned it may be neglected without sensible error. [FIGURE OF THE EARTH.]

In order to determine the relative positions of points on a sphere in the most commodious manner, mathematicians refer them to two *great circles*; that is to say, circles formed by the intersection of the surface of the sphere by a plane passing through its centre. The earth is a body which revolves about an axis of rotation; the position of this axis, therefore, with respect to the celestial constellations, determines one great circle, namely, the *equator*, or the circle which is equally distant from the two poles of rotation and divides the globe into two opposite hemispheres. The equator, therefore, being marked out by nature, or by the apparent revolutions of the celestial bodies arising from the real diurnal rotation of the earth, is a circle to which all places are most conveniently referred: and it has this property, that it never undergoes any change of place on the sphere; for astronomers have proved that since the date of the earliest observations, the poles of rotation, and consequently the equator, have always maintained the same invariable position on the earth's surface.

The distance of a place from the equator cannot be directly measured; but by means of astronomical observations we can determine that distance in aliquot parts of the earth's circumference, that is in degrees of a great circle. It is not, however, sufficient to know how many degrees a place is distant from the equator. It is necessary, also, in order to distinguish it from all other places, to know how it is situated with respect to a certain *meridian*, or great circle perpendicular to the equator, and consequently passing through the poles. In reference to the diurnal rotation of the earth, all meridians are in precisely the same circumstances; the choice is consequently entirely arbitrary, and geographers, as well as astronomers, generally select that which passes through the capital of their own country as the circle to which they refer all other places. The equator and the assumed meridian thus form the coordinates of the sphere. The distance of any place from the equator, measured on the arc of the meridian, is the *latitude* of the place; its distance from the assumed meridian, measured on a circle parallel to the equator, is its *longitude*; and when the latitude and longitude of any place are both known, the position of the place itself is entirely determined. The latitude of a place is ascertained by observing the height of the pole above the horizon of that place; and the longitude of one place in respect of another, by the interval of time which elapses between the passage of any celestial body over their respective meridians. [LATITUDE and LONGITUDE.]

Besides the rotatory motion about its axis, the earth has also a motion of revolution about the sun, which is completed in the course of one year. The first of these motions causes the succession of day and night; the second the vicissitudes of the seasons, and the inequality of the length of the natural days. These two last phenomena depend on two circumstances: first, that the axis of the earth is not perpendicular to the plane of the ecliptic, or the plane in which the annual revolution is performed; and second, that the extremities of this axis, or the two poles of rotation, continue to be directed to the same points of the celestial sphere during

the whole time of the revolution. Hence it follows that the plane of the equator, though invariable in respect of absolute space, is continually changing its position in respect of the sun; and the apparent effect is the same as if the sun had a vibratory motion in the heavens, rising above the plane of the equator E E one half of the year, and falling below it during the other half.



When the sun is in the equator at S, the two poles of the earth *n* and *s* are in the great circle which divides the illuminated from the dark hemisphere. When the sun reaches his greatest northern declination at S′, the illuminated hemisphere is *a* E *a′*, and the north pole *n* comes considerably within it. On the other hand, when the sun's declination is south, as at S″, the south pole *s* comes into the illuminated hemisphere, while *n* is left in darkness. When the sun is at S, his apparent diurnal motion is performed in the equator, and the days and nights are of equal length all over the world. The angle which the planes of the equator and ecliptic make with each other is about 23½°; consequently, since the greatest declination of the sun from the equator is the same quantity, it must happen that at midsummer the sun is 23½° to the north of the equator, and at midwinter 23½° to the south of it. The inequality of the natural days is an immediate consequence of the sun's declination: for as the solar rays come to the earth nearly parallel, one half of the globe must always be illuminated at once, and the other half in darkness; consequently when the sun declines 23½° to the north of the equator, all that part of the earth which is within 23½° of the north pole will remain, while the earth performs its diurnal revolution, within the illuminated hemisphere. A small circle of the sphere parallel to the equator, and at the distance of 23½° from the pole, is called the *polar circle*; and at this latitude the sun, when at his greatest declination, comes exactly to the horizon at midnight, without setting; consequently the length of the longest day is twenty-four hours. At the equator the length of the day is always twelve hours; and from the equator to the polar circle the length of the longest day increases with the increase of latitude; and from the polar circle to the pole the length of time during which the sun continues above the horizon without setting increases with the latitude from twenty-four hours to six months. The two small circles of the sphere parallel to the equator, which limit the sun's greatest declination, are called the *tropics*; and the whole surface of the globe is divided by the two tropics, and the two polar circles, into five *zones* or spaces; namely, the *torrid zone*, which is included between the two tropics, or extends 23½° on either side of the equator; the two *temperate zones*, or the spaces included between the tropic and polar circle in each hemisphere; and the two *frigid zones*, or the spaces between the poles and their respective polar circles. These may be called the astronomical divisions of the globe, as they depend on the position of the earth's axis of rotation with respect to the plane of its orbit, and are determined by astronomical observations.

Geography, Physical.—Has for its object the description of the principal features of the earth's surface, as consisting of land and water; the extent and configuration of the continents and islands; the elevation and direction of the mountain chains; the conformation of the plains and valleys; their altitude above the level of the sea; the soil, climate, and animal and vegetable productions of different countries. It embraces also the various phenomena of the ocean, which may be classed under the term Hydrology; the depth of the sea, and the inequalities of its depth, its saltness and temperature; the direction and velocity of currents, the tides, the polar ice, &c. In like manner it comprehends also many of the questions which are usually treated under the terms Meteorology and Climate; the mean temperature of different countries; the height of the snow-line; the prevailing winds; the barometric pressure; the quantity of annual rain, of evaporation, &c.; and the effect of all these circumstances on the condition of the human race.

On casting our eye on a globe or map, we immediately perceive the very unequal distribution of land and water on the surface of the earth. The land occupies a very little more than one-third of the whole surface, and the water all the remaining portion. Nor is the inequality of the distribution in respect of the two hemispheres less remarkable. Of the whole land about four-fifths is situated in the northern hemisphere, and the remaining one-fifth in the southern. In a general view, the land consists of three great masses: the *old continent*, which comprehends Europe, Asia and Africa; the *new continent*, or America; and *New Holland*—which are separated from each other by the great oceans. The general features of the two continents differ remarkably. In the old continent the general direction of the land, and of the great mountain chains, is from west to east almost parallel to the equator; while in America the general direction is from north to south, along the meridian. Thus the four great systems of mountain ranges in Asia—namely, the Altai, the Thian-chan, the Kuen-lun, and the Himalaya—all stretch from west to east; and the Andes, which extends from one extremity of America to the other, ranges at right angles to this direction from north to south. Another striking feature of the land is, that all the great peninsulas are pointed to the south pole. This is the case with South America, Africa, Arabia, Hindustan, Malaya, Cambodia, the Corea, Kamtschatka, California, Alasca, Greenland, Florida, Italy, &c.; in short, the only two exceptions are Yucatan in the gulf of Mexico, and Jutland in the German Sea, which

are both formed of alluvial land, and may therefore be supposed to owe their formation to partial influences which have not operated on the great continental masses. This similarity of disposition can only be attributed to the agency of some mechanical cause; and the phenomena strongly suggest the idea of the terraqueous masses having been shaped into their existing forms by the action of a great wave or current flowing from the southern to the northern pole. [ATMOSPHERE; CLIMATE; GEOLOGY; TIDES; WIND; &c. See also an excellent article on the general subject by Dr. Traill in the *Encyclopædia Britannica*.)

GEOGRAPHY, POLITICAL.—Wherever the natural features of portions of the globe lead, or seem to lead, to characteristic political phenomena, geography may help to interpret the laws of this branch of practical science. For instance, the peculiar configuration of Greece was cited in ancient times as suggestive of those municipal constitutions which belonged in an eminent degree to its political system, and which developed or aided in so marked a manner the peculiar intellectual capacity of its former inhabitants. Similarly, the physical features of the central part of the North American continent have constantly been cited as necessitating the adoption and maintenance of federal institutions. Again, the geographical position of the British Islands may be fairly understood to contribute, in no small degree, to the great commercial importance which they have achieved.

Political geography is closely related to statistics, and supplies, indeed, the principles for which statistics supply facts. It need hardly be said, however, that there is a strong tendency towards hasty generalisation from statistics, and towards rash inductions from geography. The danger is the greater in the latter case, for the obvious reason that though societies are largely influenced by external circumstances, they may nevertheless adapt themselves to them, and will be greatly controlled by antecedent facts. For instance, any argument adverse to the possible organisation of a united political system in the Italian peninsula, if gathered from its mediæval history, might be a fallacy similar to that which led the first Napoleon to call Italy a mere geographical expression. [STATISTICS.]

Geology (Gr. γῆ, *earth*, and λόγος). The science which treats of the earth's history, of the causes that have produced change in the materials of the earth's crust, of the successive changes that have taken place in the organic and inorganic kingdoms of nature, of the influence of these changes in modifying the materials, and of the nature and various conditions of rocks and their contents.

Geology proper is either, 1. DESCRIPTIVE GEOLOGY; 2. PHYSICAL GEOLOGY; or 3. PRACTICAL GEOLOGY. Physical Geology is too incomplete to admit of distinct notice. The other departments are treated under their respective headings.

A rational history of the world may be said to have originated with Aristotle, who carefully observed the changes going on upon the earth, and referred various phenomena to similar causes of change. In the twelfth chapter of the *Meteorics* he observes that the distribution of land and sea, in particular regions, does not endure through all time, but that sea covers ancient land, and land now exists where there was once sea. He adds, 'There is reason for thinking that these changes take place according to a certain system and within a certain period.'

After Aristotle, Strabo speculated with singular judgment and profoundness on the causes suggested to explain the frequent occurrence of marine shells where the sea has never been known to reach in modern times. He accounts for them by assuming that the same land is sometimes raised up and sometimes depressed, the sea being also simultaneously raised and depressed. 'It is proper,' he concludes, 'to derive our explanations from things which are obvious and in some measure of daily occurrence, such as deluges, earthquakes, and volcanic eruptions, and sudden swellings of the land beneath the sea.'

Although, then, before the Christian era and for many centuries afterwards there was no very clear comparison of facts relating to the earth's history, there were sensible and useful suggestions, and a sound basis of philosophy. There is, however, no proof of research in this department of science during the middle ages, nor did geological phenomena again attract attention till the beginning of the sixteenth century.

The origin of fossils was the first subject of enquiry, and the north of Italy the place of discussion. To Fracastoro, in 1520, is due the credit of having clearly put forward the only rational explanation. It was long, however, before this was admitted, and another century elapsed during which the subject was still under discussion. Even so lately as in 1670 it was necessary seriously to controvert the notion that fossils were due to accidental causes, or, in other words, were *lusus naturæ*, 'tricks of nature.'

During the whole of the eighteenth century, the progress of geology proper was irregular. Already before the commencement of that period, Lister had intimated that many fossils belonged to extinct species, and Leibnitz had theorised on the result of repeated invasions of the sea. Ray also had enlarged on the effects of running water, and Woodward had made those collections which show how closely he observed. It was not till 1760 that any more rational views than those of the physico-theologists were advanced; but from that time commenced the publication of a series of special descriptions which ultimately led to the establishment of the doctrines at present held. The battles between the Neptunists and Vulcanists then raged, and continued to distract the attention of those who would otherwise perhaps have devoted themselves to the study of facts.

At last, in 1790, appeared the 'tabular view' of William Smith, a contribution far more important than might at first appear, inasmuch as it laid the foundation of that great series of observations on which all progress of the science has since rested. Leaving the advocates of Werner and Hutton to fight in words, the Geological Society of London was soon afterwards founded for the purpose of obtaining and publishing positive knowledge. This and other societies that have succeeded it, and the labours of many eminent individuals, have at length placed the science on its proper basis. The present state and modern discoveries in geology will be noticed in other articles. They are the result of a large amount of patient investigation, and include a variety of facts in various departments of science. The conclusions and theories of modern geologists are generally put forward with a sounder basis of facts, and less reference to merely speculative views, than was formerly the case; but there is still much tendency among a large class of writers to mix up other enquiries and introduce foregone conclusions even when treating of questions of pure geological science.

The progress of discovery in geology for many years past has been much governed by the advance of PALÆONTOLOGY. Fossils are regarded as characteristic of formations; and by a careful knowledge and comparison of groups of fossils, all the principal groups of strata in different countries, or different parts of the same country, can alone be clearly identified as contemporaneous. As, however, only certain parts of plants and animals are generally preserved in a fossil state, and these are not always the most important for determining species, it is evident that a very limited number of natural groups are available. In botany especially, as the comparison of species is uncertain and difficult without all the floral and germinating parts, the mere fragments of leaves and wood usually found are of little value. In zoology it is only the shells and cases of many animals that remain, while very many large groups of soft animals without skeletons are never indicated at all. Even of the higher animals, as the vertebrata, the skeletons of fishes, a few detached bones of birds, and bones of reptiles and quadrupeds, must form the basis for all investigations. Thus geological discovery is unable to advance so rapidly as might be expected from the varied nature of the observations. [See DESCRIPTIVE GEOLOGY; ECONOMIC GEOLOGY; ENGINEERING GEOLOGY; ROCKS; CLASSIFICATION; PALÆONTOLOGY, and the articles referred to under these headings.]

Geomancy (Gr. γῆ, *earth*, and μαντεία, *prophecy*). Divination by points or circles made on the earth. It was termed by old writers 'a part of natural magic, the daughter and abbreviation of astrology.' Geomancy was among the acts of divination most sedulously cultivated by professors of that science in the fifteenth and sixteenth centuries. Nativities were cast, fortunes predicted, and oracular obtained to questions, by the inspection of certain combinations of lines and figures representing the conjunctions of the planets, &c. [ASTROLOGY.]

Geometric Mean. The second term of a geometrical progression consisting of three terms, or the second of three continued proportionals. In the case of two numbers, it is easily shown to be equal to the square root of their product. Any number of terms inserted between two given terms, so that the whole may form a geometrical progression, are said to be geometric *means* between those two. The celebrated *Delian problem* reduces itself to the insertion of two geometric means between given extremes. [DUPLICATION OF THE CUBE.]

Geometrical. The meaning of this adjective as opposed to *algebraical* is sufficiently obvious; when applied to a *construction*, however, it has a more technical signification. The ancient geometers admitted only two instruments: the straight line and the circle. Every construction which required the use of any other curve or instrument, they called *mechanical* as opposed to *geometrical*.

Geometrical Progression. A series of numbers, each of which is obtained from the preceding one by multiplication by a constant number called the common *ratio*. According as the latter is greater or less than unity, the progression will be an increasing or decreasing one. If, generally, a_n denote the n^{th} term of a geometrical progression whose common ratio is r, and s_n denote the sum of the first n terms, we have $a_n = a_1 r^{n-1}$ and

$$s_n = a_1 \frac{1-r^n}{1-r},$$

two equations which embrace the whole theory of geometrical progression. From them any two of the five *elements* a_1, a_n, r, n, and s_n, can, theoretically, be found when the remaining three are given. When r is positive and less than unity, the term r^n in the numerator of s_n becomes of less importance, the greater the value of n; that is to say, the sum of the series is always less than $\frac{a_1}{1-r}$, but approaches more and more to this limit, the greater the number of terms; $s_\infty = \frac{a_1}{1-r}$ is accordingly said to be the sum of the *infinite geometrical progression*, whose first term is a_1, and ratio r.

Geometry (Gr. γεωμετρία, from γῆ, *earth*, and μέτρον, *measure*). The science which treats of the properties of figured space. The etymology of the term suggests the object to which geometry was first applied, viz. the measurement of land. It is pretended that the science was invented in Egypt, where the annual overflowing of the waters of the Nile obliterated the landmarks, and rendered it necessary to have recourse to measurement in order to ascertain the proper allotment of each individual; but whatever may have been the origin of the

term, the occasions on which it is necessary to compare things with one another in respect of their forms and magnitudes are so numerous in every stage of society, that a geometry more or less perfect must have existed since the first dawn of civilisation. In geometry, bodies are considered only in reference to the properties of extension or magnitude, figure, and divisibility. Every body occupies an indefinite space, a certain determinate place, or finite portion of space, which is called its *volume*. The limits or boundaries which distinguish the place of the body, and separate it from the surrounding space, are called *surfaces*; a surface is therefore common to the two portions of space which it separates. As the limitation of space gives rise to the idea of surface, so the limitation of surface produces *lines*, a line being the boundary of a surface, or the place in which two surfaces intersect each other, and therefore common to both. In like manner the limitation of a line, or the intersection of two lines, produces a *point*. But a point marks only position, and has no properties. A line has length; a surface length and breadth; and a volume length, breadth, and thickness. Hence the properties of lines, the properties of surfaces, and the properties of volumes or solids, comprehend the objects of geometry.

From Egypt the science of Geometry is said to have been transported into Greece by Thales; but the assertions on which this supposition is grounded are utterly rejected by Sir G. Cornewall Lewis (*Astronomy of the Ancients*). The celebrated proposition of the square of the hypothenuse was the discovery of Pythagoras. Anaxagoras of Clazomene composed a treatise on the quadrature of the circle; and Plato had certainly made considerable advances in the science, as is proved by the simple and elegant solution which he gave of the duplication of the cube. About fifty years after the time of Plato, Euclid collected the propositions which had been discovered by his predecessors, and formed of them his famous *Elements*; a work which, in England, is still regarded by many as the best introduction to the mathematical sciences. It consists of fifteen books, of which thirteen are known to have been written by Euclid; but the fourteenth and fifteenth are supposed to have been added by Hypsicles of Alexandria. Apollonius of Perga, about 250 years B.C., composed a treatise on the *conic sections*, in eight books; and he is said to have been the first who applied to those curves the appellations by which they have ever since been distinguished—namely, the *parabola*, the *ellipse*, and the *hyperbola*. [Conic Sections.] About the same time flourished Archimedes, the most illustrious of the ancient philosophers. He distinguished himself in geometry by the discovery of the beautiful relations between the sphere and cylinder, by his work on *conoids* and *spheroids*, by his discovery of the exact quadrature of the parabola, and of the approximate rectification of the circle. In the list of names which have come down to our times in connection with geometry, we may mention Eudoxus, Archytas, Eratosthenes, Aristarchus, Dinostratus, and Nicomedes; but for an account of the discoveries or inventions by which they are individually celebrated, we must refer to Montucla's *Histoire des Mathématiques*. The school of Alexandria produced Pappus and Diophantus; but the Greek geometry, though it was afterwards enriched by many new theorems, may be said to have reached its limits in the hands of Archimedes and Apollonius; and a long interval of seventeen centuries elapsed before this limit was passed. In 1637, Descartes published his *Geometry*; a work which will ever be remarkable, as containing the first systematic application of algebra to the solution of geometrical propositions. Soon after this followed the discovery of the *infinitesimal calculus*; and from that time to the present geometry has shared in the general progress of all the mathematical sciences. Besides Montucla's work, Chasles' *Aperçu Historique* (Brussels 1837) may be consulted with advantage with respect to the origin and developement of geometrical methods. Of the works on Ancient Geometry, the following may be mentioned: Euclid, *Elements of Geometry*, and *Book of Data*; Apollonius, *Conics*; Archimedes, *Opera*; Pappus, *Mathematicæ Collectiones*; Vieta, *Opera Mathematica*; Huygens, *Opera*; R. Simson, *Opera Reliqua* and *Loci Plani*; Stewart, *Propositiones Geometricæ*; T. Simpson, *Elements of Geometry*; Legendre, *Elements of Geometry*; Leslie, *Elements of Geometry*, &c. For an account of the numerous editions of Euclid's *Elements* (which have been translated into every European language), see Murhard, *Bibliotheca Mathematica*; but to the list contained in that work should be added the more recent edition of Peyrard, in Greek, Latin, and French (Paris 1814). An edition of the first six books, in Greek and Latin, by Camerer and Hauber (Berlin 1824), also deserves to be noticed, on account of the valuable notes with which it is accompanied.

The modern works on Algebraic or Coordinate Geometry are very numerous: we can only mention those of Plücker, *Analyt. Geom. Entwickelungen* 1828–31, *System der Analyt. Geom.* 1835 and 1852, *Theorie der Algebraische Curven* 1839, and Mobius' *Barycentrische Calcul* 1827, as having marked an epoch in the history of the science, and Salmon's *Conic Sections* 1863, *Higher Plane Curves* 1852, and *Anal. Geom. of Three Dimensions* 1862, as treating the subject from the most modern point of view.

The modern works on *pure*, as distinguished from *coordinate* Geometry, are less numerous. Poncelet's *Traité des Propriétés Projectives des Figures*, Paris 1822; Steiner's *Systematische Entwickelung der Abhängigkeit Geometrischer Gestalten*, Berlin 1832, and his *Geometrischen Constructionen*, 1833; Chasles' *Cours de Géométrie Supérieure*, Paris 1847, and his *Traité des Sections Coniques*, 1864;

Cremona's *Teoria Geometrica delle Curve Piane*, Bologna 1862; Mulcahy's *Modern Geometry*, 1864; and Townsend's *Modern Geometry of the Point, Line, and Circle*; may be mentioned as the most important and useful.

Geoponica (Gr. γεωπονικός, from γῆ, *the earth*, and πόνος, *labour*). The name of a Greek compilation of precepts on rural economy, extracted from ancient writers. The name of the compiler is unknown; but the authorities which he quotes are numerous, and deservedly celebrated. (Niclas's edition, 4 vols. 8vo. Leipsic 1781.)

Georama (Gr. γῆ, and ὁράω, *I see*). A name given to a large concave globe, or spherical chamber, having the features of the earth delineated on the concave surface, like the large globe exhibited for many years in Leicester Square. A spectator in the interior of such a globe sees a much larger portion of the surface at once than if he occupied an exterior position.

Georgics (Gr. τὰ γεωργικά, *things pertaining to husbandry*). The title of a poem by Virgil, in four books, on agriculture, and the care of cattle, bees, &c. It is considered by critics the most perfect of his works.

Georgium Sidus. [URANUS.]

Geothermometer. An instrument for measuring the earth's heat at different depths, as in wells and mines, and for determining its rate of increase with the depth. The temperature rises about one degree of Fahrenheit's scale for every seventy or eighty feet of descent; hence the inference that at the depth of a few miles the earth must be incandescent. [GLACIÈRES.]

Geraniaceæ (Geranium, one of the genera). A natural order of herbaceous or shrubby Exogens, representing the Geranial alliance, growing in most parts of the world, and nearly related to *Oxalidaceæ*, *Balsaminaceæ*, and *Tropæolaceæ*, with which they are by some botanists associated. They are distinguished by the peculiar dehiscence of their fruit, which consists of several carpels combined round a beaked torus, by the tumid joints of their stem, and by their stipulate leaves. Their sensible properties consist in an astringent principle, and an aromatic or resinous flavour. Many of them, especially those of the genus *Pelargonium*, are beautiful objects, and much cultivated in gardens.

Geranium, Oil of. A name given by perfumers to the essential oil of an andropogon. [GRASS OIL.]

Germ-cell. In Physiology, the cell which results from the union of the spermatozoon, or spermatic matter conveyed by it, with the germinal vesicle, or its nucleus. The germ-cell assimilates the surrounding yolk and propagates its kind by spontaneous fission, whence the first or parent-cell has been termed the *primary germ-cell*, and its progeny the *derivative germ-cells*.

Germ-mass. In Physiology, the materials prepared for the future formation of the embryo, consisting of the derivative germ-cells and the yolk which they have assimilated.

Germ-yolk. In Physiology, that portion of the primary yolk of the egg which is to be assimilated by the derivative germ-cells in the formation of the germ-mass. In some animals the whole yolk is so assimilated; in others, as e. g. the bird, only a very small portion; that, viz., which is included in the germ-mass or *cicatricula*.

German School. In Painting. In this school we find an attention to individual nature, as usually seen, without attempt at selection or any notion of ideal beauty. The early German painters seem to have set a particular value on high finishing, rather than on a good arrangement and disposition of the subject. Their colouring is far better than their drawing, but their draperies are generally in bad taste. Though among the painters of this school there are some who do not deserve this censure, they are not sufficient in number to change the general judgment that must be passed upon it. Wohlgemuth, Martin Schoen, Holbein, and Albert Dürer are the heads of it. Martin Schaffner, Aldegrever, Amberger, and Lucas Cranach were also masters of ability, but utterly void of taste. So were also the later masters who pursued their studies in Italy, as Golzius, and Spranger, Heintz and Van Aachen. The later masters of the seventeenth century gave more attention to nature, but of them few have handed down their names to our times, with the exception of John Rottenhammer, Adam Elzheimer, and Balthasar Denner. Compared with Italy, Spain, and France, the German school has never emerged from mediocrity. These remarks do not apply to the school now rising in Germany, which (with such leaders as Overbeck, Cornelius, Schnorr, Hess, and Kaulbach, and other still more sentimental masters of the school of Düsseldorf, now deservedly renowned both for its oil and its fresco painters) seems likely to put the German school of painting on a level with its great intellectual powers in other branches of art and science, though the German artists do not yet display the masterly powers of execution developed by the modern painters of France. In enumerating the artists of Germany of the present century, the highest praise is due to their best landscape painters, many of whom are unsurpassed by those of any other country.

German Silver. A silver-like alloy generally composed of nickel, copper, and zinc; various proportions are given, amongst which the following are said to be the best: 1 nickel, 1 zinc, 2 copper; and 8 nickel, 3½ zinc, 8 copper. It resembles the tutenag of the Chinese.

Germen (Lat. *a bud*). In Botany, the organ commonly called the *ovarium* or ovary.

Germinal Area. In Physiology, the circular or oval space formed by liquefaction and metamorphosis of a peripheral portion of the

germ-mass, preparatory to the appearance of the first trace of the proper embryo. It is divided into a central clear part called *area pellucida*, and a peripheral part called *area opaca*; the portion of the latter in which blood and blood-vessels are developed is called the *area vasculosa*.

Germinal Membrane. In Physiology, the strata of cells and nuclei of cells originally forming, and afterwards extending from, the germinal area: the external stratum is the *vertebral* layer, also called the *serous* and *animal* layer; the internal stratum is the *visceral* layer, also called the *mucous* and *vegetal* layer.

Germinal Spot. In Physiology, the nucleus of the germinal vesicle: it consists of a finely granulated substance, strongly refracting the rays of light.

Germinal Vesicle. In Physiology, a clear nucleated cell, which is the first formed and most essential part of the ovum: it is surrounded by the yolk, and passes to the periphery of that part prior to impregnation, after which the germinal vesicle becomes opaque, or disappears. It is sometimes called, after its discoverer, the *Purkingian vesicle*.

Germination (Lat. germinatio, from germen). The process by which a plant is produced from a seed. The phenomena of germination are best observed in dicotyledonous seeds; such, for instance, as the bean, pea, lupin, &c. These seeds consist of two lobes or cotyledons, enveloped in a common membrane; when this is removed, a small projecting body is seen, which is that part of the *germ* which afterwards becomes the root, and is termed the *radicle*: the other portion of the germ is seen on carefully separating the cotyledons, and is termed the *plumule*; it afterwards forms the stem and leaves. When the ripe seed is removed from the parent plant it gradually dries, and may be kept often for an indefinite period without undergoing any change; but if placed under circumstances favourable to its germination, it soon begins to grow: these requisite circumstances are a due temperature, moisture, and the presence of air. Where these are present, the seed gradually swells, its membranes burst, and the germ expands. The root is at first most rapidly developed, the materials for its growth being derived from the cotyledons; and when it shoots out its fibres or rootlets, these absorb nourishment from the soil, and the plumula is developed, rising upwards in a contrary direction to the root, and expanding into stem and leaves. For this growth the presence of air is requisite; if it be carefully excluded, though there be heat and moisture, yet the seed will not vegetate. Hence it is that seeds buried very deep in the earth, or in a stiff clay, remain inert; but, on admission of air by turning up the soil, begin to shoot forth. From experiments which have been made upon the germination of seeds in confined atmospheres, it appears that carbonic acid is evolved, and that part of the starch of the cotyledons passes into gum and sugar; so that most seeds, as we see in the conversion of barley into malt, become sweet during germination. Light is injurious to the growth of a seed. It is, therefore, obvious that the different requisites for germination are attained by placing a seed under the surface of the soil warmed by the sun's rays, where it is moistened by its humidity and by occasional showers, and excluded from light, but within reach of the access of air. The most favourable temperature is between 60° and 80°; at the freezing point none of the more perfect seeds vegetate: and at temperatures above 100° the young germ is usually injured.

When the young plant is perfected, the cotyledons, if not converted into leaves, rot away, and the process of nutrition is carried on by the root and leaves. The principal nourishment is taken up from the soil by the root, and chiefly by its small and extreme fibres; so that when these are injured or torn, as by careless transplantation, the plant or tree generally dies. The matters absorbed, consisting of water holding small portions of saline substances and of organic matter in solution, become the *sap* of the plant; and this is propelled upwards in the vessels of the stem, or of the outer layer of wood, into the leaves; here it is exposed to the agency of air and light: it transpires moisture, and occasionally carbonic acid. But the leaves also at times absorb moisture, and during the influence of light they decompose carbonic acid, and, retaining the carbon, evolve oxygen; the sap thus becomes modified in its composition, and the characteristic proximate principles of the vegetable are formed. These return in appropriate vessels from the leaves, chiefly to the inner bark, where we accordingly find the accumulation of the peculiar products of the plant: they also enable it annually to form a new layer of wood. Hence it is that the transverse section of the wood exhibits as many distinct zones as the tree is years old. We are ignorant of the causes of this circulation of the sap; but that it follows the course which has been stated is proved by the operation which gardeners call *ringing*, and which they sometimes resort to, to make a barren branch bear flowers and fruit: it consists in cutting out and removing a circular ring of bark, so as to prevent the return of the sap by the descending vessels, which at first ooze copiously; but afterwards the wound heals, and the juices are accumulated in all parts above the extirpated ring, producing tumefaction in the limb, and often inducing a crop of flowers and fruit, or causing them to appear earlier than on the uncut branches. If a tree be wounded so as to cut into the central portions of the wood, or the outer layer of new wood, the flow of ascending sap is then seen to take place upon the lower section, where are the vessels that carry it up to the leaves; and the flow of descending sap is principally confined to the upper section of the inner bark, from which, after a time, new bark is produced, and the parts again become united.

Gerocomia (a word coined from Gr. γέρων, *old, and κομέω, I am concerned about*). That part of medicine which relates to the diet and treatment of old age.

Gerund (Lat. gerundium). In Grammar, a term applied to the oblique cases of the neuter of the Latin participle passive in *dus*, which serve as a declinable infinitive active and govern the case of their verbs.

Gerusia (Gr. γερουσία, *an assembly of elders*). In Ancient History, the senate of Sparta, the aristocratic element of Spartan polity. The number of this council was thirty, including the two kings; and the qualifications of its members were, pure Spartan blood, and an age not below sixty years. The election was performed in a primitive manner by acclamation, the candidates being brought forth one by one before the people. He who was greeted with the loudest applause was held to receive the highest honour next the throne. The functions of the gerusia, so far as they can be determined, were partly deliberative, partly judicial, and partly executive. It prepared measures which were to be laid before the popular assembly; it exercised a criminal jurisdiction, with power of capital punishment, and was also invested with a kind of censorial authority for the correction of abuses; but it is not likely that the ephors would permit any exercise of this authority which would interfere with their own. (Müller's *Dorians*.)

Gesith. [Thane.]

Gesneraceæ (Gesnera, one of the genera). A natural order of herbaceous Exogens, inhabiting the tropics, allied to *Bignoniaceæ*; from which it differs in the partly inferior one-celled ovary, apterous seeds, and habit; from *Cyrtandraceæ* in the one-celled ovary, simple placenta, and albuminous seeds; from *Scrophulariaceæ* by the same characters, with the exception of the seeds. The fruit, when succulent, is sometimes eatable, mucilaginous, and sweetish. Many beautiful species of *Gloxinia*, *Gesnera*, and *Sinningia* are known in our gardens. Botanists have generally united the *Cyrtandraceæ* with them as a sub-order. [Cyrtandraceæ.]

Gesture Language. The gesture language of savage tribes must be carefully distinguished from the alphabet in which the deaf and dumb are taught to converse by teachers who can speak. In the latter system, the signs represent letters or words: in the former, they directly represent ideas. Hence savages who are accustomed to converse by signs, can with ease communicate with deaf and dumb children in civilised countries. The imperfect spoken language of many tribes is still eked out by the help of this gesture language, which, in the belief of some recent writers on the subject, is the original utterance of mankind, out of which speech has developed itself more or less fully among different tribes. (Tylor's *Researches into the Early History of Mankind.*)

Geum (coined from Gr. γεύω, *to give a relish*). The Avens or Herb Bennett, *G. urbanum*, is a native plant of the Rosaceous order with lyrately pinnate leaves and small yellow flowers. Its root, called by the old herbalists Clove-root, has an aromatic clove-like odour, and possesses astringent properties. It was at one time put into ale to give it a clove-like flavour and prevent its turning sour, and has been recommended to be chewed by those who are troubled with foul breath.

Geysers (from an Icelandic word signifying *raging* or *roaring*). The celebrated spouting fountains of boiling water in Iceland. The Geysers are situated about thirty miles from the volcano Hecla, in plains full of hot springs and steaming fissures. Their jets are intermittent, and the height to which they rise appears to vary much at different times. Olafsen and Povelsen estimate that of the Great Geyser, when they saw it, at 550 feet. Few English travellers have seen it spout higher than 90 or 100 feet; but Mr. Henderson saw it reach 150 feet in 1815, and one of the smaller Geysers, when a stone was thrown into it, spouted to the height of 200 feet.

For the most recent views regarding the origin, duration, and ultimate extinction of the Geysers, see Professor Bunsen's 'Researches on the Volcanic Phenomena of Iceland,' and a lecture on the same subject by Professor Tyndall. (*Proceedings of the Royal Institution* 1853.) [Spring, Intermittent.]

Ghauts. A term applied originally to the narrow and difficult passes in the mountains of Central Hindustan, but which has been gradually extended to the mountains themselves. They consist of two great chains extending along the east and west coasts of the Deccan, parallel to each other, or rather diverging, and leaving between them and the sea only a plain of forty or fifty miles in breadth. The precise altitude of these mountains has not been ascertained, but their general elevation is from 3,000 to 4,000 feet; and while the extent of the Eastern Ghauts has been limited to a line of 300 miles, the chain of Western Ghauts is said to extend without interruption nearly 1,000 miles. (Murray's *Encyclopædia of Geography.*)

Ghea Butter, also called **Galam.** A fat oil, closely resembling palm oil. It is the produce of a West African palm, the *Micadenia* or *Bassia Parkii*, is of a greyish-white colour, and melts at a temperature of 97° Fahr.

Ghebres. [Guebres.]

Ghee. A kind of butter used by the natives of India. It is prepared by boiling fresh-drawn milk in earthen pots for about an hour, and adding to it, when cooled, a little curdled milk, called *tyre*, to make it coagulate. It is afterwards churned, some hot water being added during the process. The smell and flavour are strong and coarse.

Ghibellines. In Italian History, the name of a political party, which maintained the supremacy of the German emperors over the Italian states, and their claims to investiture, &c., disputed by the popes. [Guelfs.]

Ghost, Holy, Order of the. The principal military order of France under the old régime; instituted in 1574 by Henry III., for nobles only; abolished at the Revolution; reconstituted by the Bourbons.

Giant's Causeway. [BASALT.]

Giants (Gr. γίγαντες). In the Homeric mythology, the aboriginal inhabitants of Thrinakia, who for their impieties were extirpated by Eurymedon. (*Od.* vii. 59.) In Hesiod they are beings produced by the blood of Uranus (or heaven) falling upon Ge (the earth); by later writers they are frequently confused with the Titans. In Northern mythology, the Trolls, Frost Giants, &c. represent, like the Homeric Gigantes, the original people of the land. See a learned and amusing article on this subject in the *Encyclopædia Metropolitana.*

Giaour (Turk. *a dog*). An epithet applied by the Turks to all, but more especially to Christians, who do not profess adherence to Mohammedanism.

Gib. The fixed iron wedge used in conjunction with the *cotter*, or movable one, for the purpose of wedging up the parts of machinery. It has several other meanings in mechanics; thus, the arm of a crane, which supports the weight and round which the movement takes place, is called a *gib.*

Gibbose (Lat. gibbosus, from gibba, *a hunch*). Humped. When a surface presents one or more large elevations.

Gibbous (Lat. gibbus, *protuberant*). This term is applied in Astronomy to the swelling or convex appearance of the moon when more than half full or enlightened. In the telescope, the planets Mercury, Venus, and Mars exhibit a similar appearance.

Gibbsite. The native hydrated alumina of Massachusetts, named after Colonel Gibbs.

Giddiness. [SCOTODINIA.]

Giesecklte. A mineral discovered in Iceland by Giesecke. It is a hydrated silicate of alumina and potash, and occurs in brownish hexagonal prisms.

Gift. In Law, in its general sense, a conveyance which passes either lands or goods. But when restricted to immovable property, it signifies in its proper sense the creation of an estate tail. [FEE TAIL.] At the present time, however, the term *gift*, even in legal documents, usually bears only its popular sense of a gratuitous donation of money or some other description of property.

Gig. A light carriage drawn by one horse. *Gigs* or *gig machines* are rotary cylinders covered with wire-teeth, for teasling woollen cloth.

GIG. In Naval Language, a light boat attached to a ship. It is rowed by two, four, or six alternate oars, and is ordinarily kept for the use of the officers.

Giga or **Jig** (Ital.). In Music, an air for dancing in triple time, usually $\frac{6}{8}$ or $\frac{12}{8}$.

Gigantomachia (Gr.). In Painting, representations of combats with or between giants. The term is more particularly applied to the conflicts waged between Jupiter and the giants. [GIANTS.] The most remarkable work of this class is the 'Fall of the Giants' in the Palazzo del Tè at Mantua, painted under the superintendence of Giulio Romano.

Gilbertines. A religious order founded by Gilbert of Sempringham, in Lincolnshire, in the twelfth century. It possessed about twenty-five houses in England at the time of the dissolution.

Gilbertite. A white micaceous mineral composed chiefly of silica, alumina, and lime, from St. Austel, in Cornwall, named by Dr. Thomson, after Mr. Davis Gilbert, formerly President of the Royal Society.

Gilding. The application of a superficial coat of gold on wood, metal, and other materials. The beauty and durability of gold render it the most valuable of all ornamental substances; but, on account of its weight and high price, its use in these respects would be greatly restricted, were it not the most extensible and divisible form of matter, so that it may be made to cover a larger surface than an equal quantity of any other body. Metals are usually covered with gold by various processes: one of these, called *water-gilding*, is now almost disused: it consisted in perfectly cleaning their surface, and then, in the case of silver, for instance, rubbing it over with a solution of gold in mercury, *amalgam of gold*: the vessel was then heated over a clear charcoal fire, by which the mercury was driven off, and the gold left adhering to the silver surface, upon which it was afterwards burnished. The surface of copper or brass was prepared by cleaning and rubbing it over with a solution of nitrate of mercury, which amalgamated the surface, and enabled the gold amalgam, when subsequently applied, to adhere; heating and burnishing were then resorted to as before. Brass and copper buttons were gilt in this way; the quantity of gold used being so small that twelve dozen buttons of one inch diameter were completely gilt upon both surfaces by five grains of gold. At present, nearly all gilding upon metals is performed by electro-chemical agency. The surface to be gilt is rendered electro-negative, and immersed in a proper solution of gold. Other kinds of gilding are performed by gold leaf, which, if intended for outdoor work, is laid on by the help of *gold size*, i.e. drying oil mixed with calcined red ochre; or, if for picture and looking-glass frames, they are prepared by a size made by boiling parchment clippings to a stiff jelly, and mixed with fine Paris-plaster or yellow ochre. The leaves of books are gilt upon the edges by brushing them over, while in the binder's press, with a composition of four parts of Arminian bole and one of powdered sugar candy mixed up with white of egg; this coating, when nearly dry, is smoothed by the burnisher, then slightly moistened, and the gold leaf applied and burnished. To impress gilt figures on book covers, the leather is dusted over with finely powdered mastic; the iron tool by which the figure is made is then moderately heated and pressed upon a piece of leaf-

gold, which slightly adheres to it; being then immediately applied to the leather with a certain force, the tool makes an impression, and, softening the mastic, transfers and fixes the gold. In gilding glass and porcelain, powdered gold is blended with gum-water and a little borax, and applied by a camel-hair pencil; the article is then put into an oven or furnace; the gum burns off, and the borax, by vitrifying, cements the gold to the surface, upon which it may afterwards be polished by the burnisher. Sulphide of gold is also used in the potteries for the same purpose.

Gill. A measure of capacity equal to the fourth part of a pint. Miners apply the term to a pint.

Gilliesiaceæ (Gilliesia, one of the genera). A small natural order of Exogens, allied very nearly to *Liliaceæ*. Their principal peculiarity consists in having irregular flowers, surrounded externally by calyx-like bracts. They inhabit Chili, and are of no known use.

Gills (A.-Sax. geahlas). In Physiology, parts of the body are so called in which the blood-vessels are in greater number than is necessary for mere preservation or growth, and are minutely subdivided for the purpose of submitting the blood to the influence of air contained in water.

Gimbals or **Gimbols** (Lat. gemellus, *twin*). A piece of mechanism consisting of two brass hoops or rings which move within one another, each perpendicularly to its plane, about two axes, placed at right angles to each other. A body suspended in this manner, having a free motion in two directions at right angles, will assume the vertical position: hence the apparatus is employed for suspending portable or mountain barometers, sea compasses, &c.

Gimbernat's Ligament. The tendinous expansion of the lower portion of the oblique muscle of the abdomen, by some defined as the third insertion of *Poupart's ligament*.

Gimp. Silk twist, interlaced with brass or other wire.

Gin (Fr. genièvre, *juniper*). Alcohol flavoured by the essential oil of juniper. It was originally made by the Dutch, and is hence distinguished in this country by the name of Hollands. The liquor bearing the above name in this country is of British manufacture, and is frequently flavoured by oil of turpentine, and rendered biting upon the palate by caustic potash. In Holland, the finest gin bears the name of Schiedam, the principal place of its manufacture, where there are many distilleries. [Spirits.]

Gin. A species of machinery used in mining operations, whereby a rope, wound round a large horizontal drum, raises, or lowers, the buckets containing the workmen or the produce of the mine. These engines are often worked by a horse traversing a circle.

Ginger (Gr. ζιγγίβερις). The dried rhizome of *Zingiber officinalis*, a native of the East Indies, and abundantly cultivated in America and the West India islands, whence Europe is chiefly supplied. It is a good stimulant and carminative; and the fresh root preserved makes an agreeable, warm, and not very unwholesome sweetmeat. The acrimony of ginger appears to reside in a resinoid substance, which is soluble in alcohol; hence a spirituous tincture of ginger contains the virtues of the root, and is used under the name *essence of ginger*.

Gingelly. The name of an oil imported from the East Indies for use in lamps. It is expressed from the seeds of *Sesamum indicum*.

Gingham. The name given to a kind of cotton cloth, the manufacture of which was long confined to Lancashire.

Ginglymostoma. In Ichthyology, a genus of small sharks or dog-fish belonging to the family of *Scylliidæ*, subdivided into two species. They are characterised by a blunt snout, a long barbel from the inner side of the nostrils; the corner fold of the mouth divided by a deep transverse furrow, while the under portion is subdivided by a longitudinal furrow. The teeth, of which there are ten rows, have a simple rhomboidal base, a conical mesial point, and from two to four toothlets on each side. Their liver abounds in a fine oil, which is the only product they yield useful to man.

Ginkgo-tree. The *Salisburia adiantifolia*, a deciduous tree, native of Japan, where it is called Ginkgo, Gin-an, or Its-jo. It forms a conical spiry-topped tree of considerable height, and is remarkable for its leaves, which in their fan-shaped form and straight venation resemble those of the Maidenhair fern, whence it is called also the Maidenhair-tree.

Ginglymus, Ginglymoid (Gr. γιγγλυμοειδής, from γίγγλυμος, *a joint*). Hinge-like. An anatomical term applied to joints formed for motion in one plane.

Ginseng. A Chinese word applied to the root of the *Panax Schinseng* and *P. quinquefolium*. It has a bitter-sweet flavour, and is considered as a powerful restorative in China, where its consumption is very great. *P. quinquefolium* is found chiefly in the northern parts of Asia, and in America; but the Chinese draw their supplies almost wholly from America. In 1852, there were sent from the United States to China 500,000 lbs. of ginseng, valued at 120,000 dollars. (*Commercial Dict.*)

Gipsy. [Gypsy.]

Giraffe (Arab. kh'ariffa). The tallest quadruped, and the largest and most singular of the Ruminant order. The head of the giraffe resembles that of the camel in the absence of a naked muzzle, and in the shape and organisation of the nostrils, which are oblique and narrow apertures, defended by the hair which grows from their margins, and surrounded by cutaneous muscular fibres, by which the animal can close them at will. This is a beautiful provision for the defence of the air-passages and the irritable membrane lining the olfactory cavities, against the fine particles of sand which the storms of the desert raise in almost suffocating clouds. The large, dark,

and lustrous eyes of the giraffe, which beam with a peculiarly mild but fearless expression, are so placed as to take in a wider range of the horizon than is subject to the vision of any other quadruped. While browsing on his favourite acacia, the giraffe, by means of his laterally projecting orbits, can direct his sight so as to anticipate a threatened attack in the rear from the stealthy lion, or any other foe of the desert. To an open attack he sometimes makes a successful defence by striking out his powerful and well-armed feet; and the lion is said to be frequently repelled and disabled by the wounds which the giraffe has thus inflicted with his hoofs. It is essentially a true Ruminant, having a stomach divided into four compartments, the paunch being simply papillose, without water-bags; and the reticulum with extremely shallow hexagonal cells, as in the reindeer. It is also a horned Ruminant, the horns being two in number, small, straight, and simple, like those of the pricket deer. But in the giraffe the bony base of each horn is articulated by a broad rough epiphysial basis to the cranium; it is covered by a vascular periosteum and a hairy integument, which is not deciduous. These horns, or rather antlers, terminate in a truncate extremity capped with a callous plate, and fringed with long and strong black hairs: they are present in both sexes, as in the reindeer, but are larger in the male, and are by no means the insignificant weapons that they have been supposed to be. The median protuberance is a simple thickening of the contiguous parts of the frontal and nasal bones. In the form of the mouth the giraffe differs from every other Ruminant. The upper lip is not bifid, as in the camel; and though it is prolonged and covered with hair, as in the elk, it differs in its elegant and tapering form.

The giraffe has a long neck, and has not spurious hoofs, and so far it resembles the camel; but the cervical vertebræ in the camel tribe present a peculiarity of structure, combined with their length, in which the giraffe does not participate. The camels have many other peculiarities of internal organisation, to some of which we find resemblances in certain ordinary Ruminants, but not in the giraffe. Its place in the Ruminant series is between the deer and the antelope. These extensive families are respectively distinguished, not only by the nature of their horns, but by a well-marked anatomical character: the gall-bladder is present in the antelopes, and not in the deer. In three giraffes lately dissected in this country, a gall-bladder was present in one, and not in the other two. In that in which it was discovered it presented an abnormal structure, being bifid at the fundus, and divided into two compartments. We may infer, therefore, that in this part of their organisation, as in the structure of their horns, the giraffes are more nearly akin to the deer tribe than to the antelopes. Yet it must not be forgotten that while we search in vain among the *Cervidæ* for an equine mane and tufted tail, such as ornament the giraffe, we find both these peculiarities combined in the gnu among the antelopes. A giraffe more than two-thirds grown will eat daily in confinement eighteen pounds of clover hay, and eighteen pounds of a mixed vegetable diet, consisting of carrots, mangold wurzel, barley, split beans, and onions; and will drink four gallons of water. They copulate in March. The female has four inguinal udders; she brings forth one fawn at a birth; and the period of gestation is fifteen months. The new-born giraffe measures six feet from the fore-hoofs to the top of the head. In a few hours it is able to follow the dam. It resembles the mature animal in the markings of the hide. The first giraffe known to have been produced in captivity was brought forth in June 1839, at the gardens of the Zoological Society of London.

Girasol (Ital. girasole). A milk-white or bluish Opal, which, when turned to the light, reflects a reddish colour; hence its name, from the Latin gyrus, *a circle*, and sol, *the sun*.

GIRASOL. The Italians gave this name to the artichoke as being a kind of sunflower; hence the English corruption of Jerusalem artichokes, followed by the invention of Palestine soup.

Girder. In Architecture, a principal beam in a floor, for supporting the binding or other joists, whereby their bearing, or length, is lessened. Girders are of several sorts, such as cast iron, wrought iron, boxed, framed, and trussed; they are now used quite as much for the support of the main walls of a building, or for the support of the roadway of a bridge, as for floors.

Girdle (A.-Sax. girdan, *to encircle*, Goth. gairda). A belt or band, of leather or some other substance, used in girding up the loins. The girdle (Gr. ζώνη, Lat. cingulum) was in use among the Hebrews, Greeks, and Romans, for various purposes, and chiefly while at work or on a journey. They were also worn by young women at all times before marriage. Hence *Zonam solvere virgineam* was a well-known phrase appropriated to the marriage ceremony. To Aphroditê or Venus was attributed by the poets the possession of a particular kind of girdle, called *cestus*, which was said to have the power of inspiring love.

It was formerly the custom in England for bankrupts or other insolvent persons to put off and surrender their girdles in open courts.

Gironde, the. In French History, a celebrated political party during the Revolution, the members of which were termed Girondists or Girondins. The name was derived from that of the department La Gironde (in which Bordeaux is situated), which sent to the legislative assembly of 1791, among its representatives, three men of eloquence and talent (Guadet, Gensonné, Verguiaud), who were among the chief leaders of the party. Its principles were republican. During the continuance of that assembly the

Girondists formed a powerful, but not always consistent party. Out of these Louis XVI. chose his republican ministers in the beginning of 1792. But after the massacres of September in that year the party in general withdrew from all connection with the Jacobins, and approximated towards the Constitutionalists. In the Convention the Girondists at first commanded a majority, but on the king's trial they were much divided; and, being pressed by the violence of the sections of Paris, they were at length expelled the assembly: thirty-four of them were outlawed, and finally twenty-two of their leaders guillotined (Oct. 7 and Oct. 31, 1793), while a few escaped, and others put an end to themselves. Perhaps the most celebrated member of the Gironde party was a lady, Madame Roland, the wife of the minister of that name, who was executed when the party fell, and whose principal writing—the *Appel au Peuple*—bears all the stamp of that high republican enthusiasm which characterised them. Various apologies and eulogies of the party have appeared. Its members were not without high qualities; but its counterpart will be found in all revolutions, in that body of men of high theoretical views of social reform and little practical knowledge, who, being commonly lifted into power by supporters more energetic but less high-principled than themselves, are sure to be thrust down in a short time by their own former adherents. (See particularly the histories of Thiers and Louis Blanc for general views on the subject; for details, the *Histoire Parlementaire* of Messrs. Buchez and Roux; and the famous, but somewhat romantic, *History of the Girondins* by Lamartine, which produced so great an effect on the public mind in the Revolution of 1848.

Girouette (Fr. *a weathercock*). Public characters who turn with every political breeze. The French published a *Dictionnaire des Girouettes*, containing the names of the most celebrated revolutionary characters, with a number of weathercocks against each, corresponding to the number of his political changes.

Girt Line.. A rope to lift the rigging and riggers up to the masthead on first rigging the ship.

Gismondine. A native hydrated silicate of alumina, lime and potash, first noticed at Capo di Bove, near Rome, by Gismondi, after whom it was named.

Githagin. A soap-like matter found in the corn cockle (*Agrostemma Githago*).

Gizzard (Fr. gésier). The proper stomach of birds; its texture differs remarkably in granivorous and carnivorous birds, being thick in the one and thin in the other.

Glabrous (Lat. glaber, *smooth*). A term applied in Mammalogy to those parts of the surface of a quadruped which are naturally devoid of hair; and in Botany and Entomology, when a surface is smooth, and devoid of hair or pubescence.

Glacial Drift. The surface of much of Northern Europe and North America is strewed at intervals with remarkable accumulations of large and small blocks of stone (some angular, some rounded), mixed with sand and clay, all heaped irregularly on the other rocks, but sometimes including stratified deposits. The solid rocks are often greatly scratched, and not unfrequently polished, under these deposits, as if they had been dragged or drifted along for some distance. Sometimes the deposits are in definite lines; sometimes the heaps have definite forms. To account for these curious heaps, of which GRAVEL is one of the component parts, it is necessary to study the action of ice, whether moving over a surface of land loaded with stones and rubbish, or broken away from the land and drifted along by marine currents. The former condition introduces the subject of GLACIERS, the latter of ICEBERGS [see those articles].

The action of a glacier in producing drift is peculiar, but easily understood. Large quantities of stones, sand, mud, and other material, derived from the hourly disintegration of rocks on high exposed mountain sides, fall into the valleys, and are there caught up by the snow, and at length, by the constant change going on in the newly forming ice, are arranged in long lines distributed through the mass. Those at the sides and bottom, pressed on by the whole weight of the moving ice, rub, scratch, and cut away the ground below, thus adding to the material moved. The whole at length reaches the place where the ice is melting, and is there accumulated or carried away by the stream. The path of the glacier is inevitably marked by these accumulations; and if at any time the glacier should melt away entirely, the rubbish would be left as drift. Such drift cannot have been moved far, and may generally be traced to its origin.

Where, however, in cold climates the glacier reaches to the sea coast, and then advances into the water till it becomes broken off, the accumulation of drift may be so distributed among the mass, that when separated, the portion of a glacier, now an iceberg, may contain an enormous load of broken rock and mud. Entering the sea, and drifted by marine currents, the huge mass thus loaded will either melt by degrees as it enters warmer latitudes, or will be caught by some shoal and stopped on its way. In the first case a multitude of blocks and stones will be strewn with a certain degree of regularity along a line of sea bottom, and will probably be drifted into hollows, or large heaps of all kinds without order or arrangement. Otherwise it will be left on the shoals and higher ledges of rock on which the bergs have stranded. Thus have been produced the various phenomena of glacial drifts. They are often greatly complicated in nature, by subsequent elevation and denudation, and the partial covering by other newer accumulations. [GLACIERS and GLACIAL PHENOMENA.]

Glacial Phenomena. Phenomena indicating glacial action. They are very numerous

and varied, and include many appearances that would not at first be thought referable to such action as that of ice. Gravel deposits generally, gravel hills of a certain form having one side steep and the other an easy slope always in the same direction, isolated boulders, surfaces of rock smoothed, rounded, scratched, or otherwise acted on by the friction of heavy bodies—these are the ordinary phenomena. Long trains of gravel and sand, indentations scooped out of rocks like ledges, ancient beaches partly covered by gravel, partly by shells belonging to arctic regions, certain bones and other remains of quadrupeds—all these are also glacial phenomena. They are all indications of a time not very distant, geologically speaking, when the greater part of the temperate region of the northern hemisphere was covered with water (the land extending towards the pole), and large quantities of glacial ice stretched away into the open valleys and fiords of the high mountain chains, breaking off into icebergs which float far down and not unfrequently strand on shoals and on some of the islands. This period is so distinctly marked by the phenomena in question, that no doubt can exist as to its continuance for a long period. [GLACIERS and GLACIAL DRIFT.]

Glacières (Fr.). In Geology, this name is given to caves full of ice, which are found chiefly in the Alpine mountains in spots quite unconnected with any glacial system. These caves are interesting chiefly as occurring in localities where the mean temperature of the surface of the earth is much above the freezing point, and at depths below the surface varying from 50 to 200 feet, thus furnishing exceptions to the rule of the increase of temperature from the surface towards the centre of the earth. One of these caves, at Monthezy in the Val de Travers, exhibits the phenomenon of alternating currents of air, moving in each direction for about twenty-two seconds, with an interval of four seconds of inaction. Among such ice-caves are the glacières La Genollière, S. Georges, Pré de S. Livres, in the Jura, and of La Baume near Besançon. Similar caves are found in Hungary, and at Yeermalik in Koondooz: and to these may be added the caves of the Jurtshellir in Iceland, and the gypsum cave of Illetzkaya-Zastchita, in the steppes of the Khirghis, south of Orenburg. (Browne's *Ice-caves of France and Switzerland.*)

Glaciers (Fr.). The name given to the immense masses of ice which accumulate on the peaks and slopes, and in the upper valleys, of lofty mountains. The phenomena of glaciers form one of the most interesting subjects of scientific investigation, whether we regard their formation, structure, or appearance. In all parts of the globe glaciers have the same general characteristics; but though the glaciers of other countries have often been described by geographers and naturalists, it is chiefly in respect to those of Switzerland that we possess detailed information. In that country, as indeed in every other, those parts of the mountains that rise above the line of congelation are covered with perpetual snow, which being partially thawed during the summer months, is on the approach of cold converted into ice, thus constituting what is called a *glacier*. The ice so formed descends along the slopes of the mountains into the valleys, by which their ridges are furrowed, and there it accumulates into vast beds or fields, presenting, where the descent is gradual, a very level surface with few crevices, but where there is a rapid or rugged declivity being rent with numerous chasms and covered with elevations rising from 100 to 200 feet. These chasms are frequently many feet wide and more than 100 feet deep. Their formation never takes place in winter, but is frequent during summer; and the daily, and almost hourly, changes to which these chasms are subject, are the chief causes of danger to travellers in ascending glaciers. (*Geographical Dictionary*, art. 'Alps.') Though the snow-line on the Alps is found at an elevation of about 8,000 feet above the level of the sea, some of the glaciers descend so far downward that their lower extremity is not more than 3,500 feet above it. This is particularly the case in the valley of Chamouni, where the singular spectacle is presented of huge pyramids of ice of a thousand fantastic shapes in juxtaposition with the most luxuriant pastures, or towering in majestic grandeur in the midst of verdant for[illegible]
the descent of the glaciers is twofold: viz. one of a slow and gradual character, by which a progressive movement of about twenty-five feet annually is effected; the other of a rapid and impetuous kind, in which a portion of the ice having been severed from the main body glides down the mountain's side, accumulating as it goes, and precipitating into the valleys beneath immense stones, fragments of rock, and other substances to which it had adhered. When the débris which the glaciers accumulate in their descent has been deposited in the valleys, it constitutes what in Savoy is termed their *moraine* or border, an essential feature in the Alpine glaciers. These borders present every variety of aspect; but their most usual appearance is that of unfathomable bogs or morasses wholly destitute of vegetation, and in many instances fraught with extreme peril to the traveller. They are generally arranged in long ridges or mounds from thirty to forty feet high; and being often two, three, or even four in number, resemble so many lines of intrenchment.

The Alpine glaciers occupy a superficial extent of 1,484 square miles. From Mont Blanc to the borders of the Tyrol there are reckoned about 400, of which the greater number vary from 10 to 15 miles long, and from 1 to 2¼ broad; their mean vertical thickness ranges from 100 to 600 feet. Besides the grand and picturesque appearance which they present externally, their lower extremities are sometimes excavated by the melting of the ice into the form of immense grottoes, adorned with the finest stalactitic crystallisations, whose bril-

liant azure tints are reflected on the streams and torrents which generally issue from these caverns, forming altogether a picture so beautiful as to defy the most faithful pencil to portray it adequately. The glacier ice does not resemble the ice found in ponds and rivers. Not being formed in layers, but consisting of small grains or crystals of congealed snow, it has neither the compactness, the solidity, nor the transparency of river ice; and though every single crystal seems perfectly white, the whole mass is of a blue colour, passing through every variety of shade, from the most feeble sky-blue to that of the lapis lazuli. From the large accessions of snow and ice which the glaciers receive, especially in winter, it might reasonably be conjectured that they must be gradually increasing in size, and would consequently in the course of time break through their usual limits and overwhelm the cultivated lands of the surrounding country. This, however, is by no means the case. It no doubt often happens that on some occasions the glaciers are observed to descend lower than usual; but, when this takes place, the warm atmosphere of the lower valleys into which they have advanced, and of which the temperature rises in proportion to their depression, operates with such powerful effect in reducing their bulk, that they are invariably found to recede proportionably. Thus nature has established a compensating process, by which an effectual though simple check is administered to the encroachment of the glaciers upon the cultivated lands of the Alpine valleys.

The results of glaciers will be best understood by a reference to the special articles on GLACIAL DRIFT and GLACIAL PHENOMENA. They have been produced on the surface of the land in many parts of Europe now altogether free from ice except during a short season in winter. This is so clear as to render it certain that there was a time, geologically not very remote, when much of the land now cultivated was covered with ice proceeding from elevations so low as to be utterly inadequate in the present climate of the district to produce a glacier of importance. It follows that they afford valuable points of geological evidence of change of climate when carefully studied with this view.

The structure and motion of glaciers have been elaborately investigated by Rendu, Agassiz, Forbes, and Tyndall. The last-named physicist, who has most recently studied the subject with much success, gives the following summary of glacier phenomena:—

'1. Glaciers are derived from mountain snow, which has been consolidated to ice by pressure.

'2. That pressure is competent to convert snow into ice, has been proved by experiment.

'3. The power of yielding to pressure diminishes as the mass becomes more compact; but it does not cease even when the substance has attained the compactness which would entitle it to be called ice.

'4. When a sufficient depth of such a substance collects upon the earth's surface, the lower portions are squeezed out by the pressure of the superincumbent mass. If it rests upon a slope, it will yield principally in the direction of the slope, and move downwards.

'5. In addition to this, the whole mass slides bodily along its inclined bed, and leaves the traces of its sliding on the rocks over which it passes, grinding off their asperities, and marking them with grooves and scratches in the direction of the motion.

'6. In this way the deposit of consolidated and unconsolidated snow, which covers the higher portions of lofty mountains, moves slowly down into an adjacent valley, through which it descends as a true glacier, partly by sliding and partly by the yielding of the mass itself.

'7. Several valleys thus filled may unite in a single valley the tributary glaciers, welding themselves together, to form a trunk glacier.

'8. Both the main valley and its tributaries are often sinuous, and the tributaries must change their direction to form the trunk; the width of the valley often varies. The glacier is forced through narrow gorges, widening after it has passed them; the centre of the glacier moves more quickly than the sides, and the surface more quickly than the bottom; the point of swiftest motion follows the same law as that observed in the flow of rivers, shifting from one side of the centre to the other as the flexure of the valley changes.

'9. These various effects may be reproduced by experiments on small masses of ice. The substance may moreover be moulded into vases and statuettes. Straight bars of it may be bent into rings, or even coiled into knots.

'10. Ice capable of being thus moulded is practically incapable of being stretched. The condition essential to success, is that the particles of the ice operated on shall be kept in close contact, so that when old attachments have been severed new ones may be established.

'11. The nearer the ice is to its melting point in temperature, the more easily are the above results obtained; when ice is many degrees below its freezing point, it is crushed by pressure to white powder, and is not capable of being moulded as above.

'12. Two pieces of ice at 32° Fahr., with moist surfaces, when placed in contact, freeze together to a rigid mass; this is called *regelation*.

'13. When the attachments of pressed ice are broken, the continuity of the mass is restored by the regelation of the new contiguous surfaces. Regelation also enables two tributary glaciers to weld themselves to form a continuous trunk; thus also the crevasses are mended, and the dislocations of the glacier, consequent on descending cascades, are repaired. This healing of ruptures extends to the smallest particles of the mass, and it enables us to account for the continued compactness of the ice during the descent of the glacier.

'14. The quality of viscosity is practically absent in glacier ice. Where pressure comes

into play, the phenomena are suggestive of viscosity; but where tension comes into play, the analogy with a viscous body breaks down. When subjected to strain, the glacier does not yield by stretching, but by breaking; this is the origin of the crevasses.

'15. The crevasses are produced by the mechanical strains to which the glacier is subjected. They are divided into marginal, transverse, and longitudinal crevasses; the first produced by the oblique strain consequent on the quicker motion of the centre; the second by the passage of the glacier over the summit of an incline; the third by pressure from behind and resistance in front, which causes the mass to split at right angles to the pressure.

'16. The moulins are formed by deep cracks intersecting glacier rivulets. The water, in descending such cracks, scoops out for itself a shaft, sometimes many feet wide, and some hundreds of feet deep, into which the cataract plunges with a sound like thunder. The supply of water is periodically cut off from the moulins by fresh cracks, in which new moulins are formed.

'17. The lateral moraines are formed from the débris which loads the glacier along its edges; the medial moraines are formed on a trunk glacier, by the union of the lateral moraines of its tributaries; the terminal moraines are formed from the débris carried by the glacier to its terminus, and there deposited. The number of medial moraines on a trunk-glacier is always one less than the number of tributaries.

'18. When ordinary lake-ice is intersected by a strong sunbeam, it liquefies, so as to form flower-shaped figures within the mass; each flower consists of six petals, with a vacuous space at the centre; the flowers are always formed parallel to the planes of freezing, and depend on the crystallisation of the substance.

'19. Innumerable liquid discs, with vacuous spots, are also formed by the solar beams in glacier-ice. These empty spaces have been hitherto mistaken for air-bubbles, the flat form of the discs being erroneously regarded as the result of pressure.

'20. These discs are indicators of the intimate constitution of glacier-ice, and they teach us that it is composed of an aggregate of parts, with surfaces of crystallisation in all possible planes.

'21. There are also innumerable small cells in glacier-ice holding air and water; such cells also occur in lake-ice; here they are due to the melting of the ice in contact with the bubble of air. Experiments are needed on glacier-ice in reference to this point.

'22. At a free surface within or without, ice melts with more ease than in the centre of a compact mass. The motion which we call *heat* is less controlled at a free surface, and it liberates the molecules from the solid condition sooner than when the atoms are surrounded on all sides by other atoms which impede the molecular motion. Regelation is the complementary effect to the above; for here the superficial portions of a mass of ice are made virtually central by the contact of a second mass.

'23. The dirt-bands have their origin in the ice-cascades. The glacier, in passing the brow, is transversely fractured; ridges are formed with hollows between them; these transverse hollows are the principal receptacles of the fine débris scattered over the glacier; and after the ridges have been melted away, the dirt remains in successive stripes upon the glacier.

'24. The ice of many glaciers is laminated, and when weathered may be cloven into thin plates. In the sound ice, the lamination manifests itself in blue stripes, drawn through the general whitish mass of the glacier; these blue veins representing portions of ice from which the air-bubbles have been more completely expelled. This is the veined structure of the ice. It is divided into marginal, transverse, and longitudinal structure; which may be regarded as complementary to marginal, longitudinal, and transverse crevasses. The latter are produced by tension, the former by pressure, which acts in two different ways: firstly, the pressure acts upon the ice as it has acted upon rocks which exhibit the lamination technically called *cleavage*; secondly, it produces partial liquefaction of the ice. The liquid spaces thus formed help the escape of the air from the glacier; and the water produced, being refrozen when the pressure is relieved, helps to form the blue veins.'

Glacies Mariæ (Lat.) or **Glace de Marie** (Fr.). Terms applied to largely foliated Mica.

Glacis (Fr.). In Fortification, a bank of earth, which forms the parapet of the counterscarp, and conceals the scarp wall. It slopes gently off to the level country.

Gladiators (Lat. gladiatores, from gladius, *a sword*). In Roman Antiquities, sword players, who were originally employed to fight at the funerals of illustrious Romans, in order to appease their manes by the effusion of blood. They were subsequently introduced into the public amphitheatres, and became one of the most favourite spectacles of the Roman people. The gladiators were either captives or condemned criminals, or else people of the lowest rank, who served for hire, the profession being considered one of the greatest infamy. In spite of this, however, under some of the emperors, persons of the first families, who had enjoyed the highest honours of the state, entered the arena, either at the command of the despot, or in order to gratify him; and even females of patrician blood, in some instances, followed their example. Gladiators did not merely use the sword, as their name strictly implies, but were armed in various ways. Thus, the Laqueatores used a noose (laqueus) to catch their opponents: and the Retiarii carried a three-pointed lance with a net (rete) wherewith to entangle their adversaries. The gladiators were, in general, desperate and ruffian characters; and considerable bodies of them were sometimes kept in the pay of wealthy and tur-

bulent citizens, or hired as bullies. Perhaps the best exposition of the opinion of the more philosophical Romans on the subject is thus given by Cicero: 'Crudele gladiatorum spectaculum et inhumanum nonnullis videri solet: et haud scio an non ita sit, ut nunc fit: cum vero sontes depugnabant, auribus fortasse multa, oculis quidem nulla poterat esse fortior contra dolorem et mortem disciplina.' (*Tusc. Quæst.* 2.) It is commonly but inexactly said, that the shows of gladiators were put a stop to by the Christian emperors. They certainly had not ceased in A.D. 404, and probably not before the conquest of Italy by the Goths. (Beugnot, *Destruction du Paganisme en Occident*, book ix. ch. ii.)

Gladiolus (Lat. dim. of gladius, *a sword*). The beautiful plants which bear this name in modern gardens are the results of intercrossing of some two or three South African species, especially *G. natalensis, floribundus*, and *cardinalis*.

Gladius (Lat.). The name of the internal horny plate of the calamaries, which was called by the Greeks ξίφος, or the sword.

Glair. The white of an egg; or any viscous transparent substance resembling it.

Glairin. *Baregin.* A nitrogenous matter existing in some sulphurous springs.

Glance Coal. [ANTHRACITE.]

Gland (Fr. glande, from Lat. glans). In Anatomy, this term is applied to those organs of the body in which *secretion* is carried on, and which appear to consist of a congeries of blood-vessels, nerves, and absorbents: they are frequently distinguished according to their secretion, into mucous, sebaceous, lymphatic, and lachrymal; or, according to their form and texture, into simple, compound, conglobate, and conglomerate.

GLAND. The cupped collar, lined with brass, which encircles the piston or air-pump rod of a steam engine where it passes through the cylinder cover; it is introduced for the purpose of holding oil or tallow for the lubrication of the working parts, and for compressing the packing of the stuffing box upon which it is screwed down. The term is generally applied in the sense of a joint holding lubricating fluid, with tight packing.

Glands or **Glandules.** In Botany, wart-like swellings of various forms, found on the surface of plants, or at the base or apex of their hairs. Lenticular glands are brown oval spots found upon the bark of many plants, especially willows, indicating the points from which roots will appear if the branch be placed in circumstances favourable to their production. They are, in fact, nothing but protuberances formed by the pressure upon the epidermis of subjacent roots attempting to pierce through it.

Glands, Buccal (Lat. bucca, *the cheek*). These glands are divided into the *parotid, sublingual*, and *maxillary*. They secrete the *saliva* or lubricating fluid of the mouth.

Glanders. A disease so called from its inflaming the glandular system. It attacks the horse, the mule, and the ass. It appears to be contagious, and from recent observations has been shown to assume two forms: the being the true glanders, a local disease especially attacking the nasal mucous ____ brane; and the other a more general affection, known under the name of *farcy*, and attacking the lymphatic or absorbent system.

Glanders may extend to the bronchial membrane, and assume several different forms. Thus, there may be merely a mild discharge, lasting for many weeks, and a cure may then be brought about; or, on the contrary, the secretion from the nose may become green, black, or sanguinolent, and ulceration of the *nasal* bones may ensue, with great destruction of soft parts.

Farcy has been differently designated, as different parts of the lymphatic system become involved. Thus we hear of *button* and of *bud* farcy, terms applied to the disease when it affects the lymphatic *glands*, and forms bosses on the extremities and other parts of the animal; and again the term *pipe* farcy is used when the lymphatic *vessel* is diseased.

Acute glanders is sometimes observed in the human subject, owing to the foul secretion from the brute animal becoming absorbed. Persons so inoculated show marked adynamic symptoms, great discharge from the nares, while a pustular eruption breaks out upon the skin. The lungs soon become involved in inflammation, and death speedily ensues.

Glans (Lat.). In Botany, an inferior indehiscent fruit, one-celled by abortion, and seated in a cupule or cup; as represented in the acorn.

Glass (Dan. glas). The manufacture of glass is one of the highest interest; and considering the comparative worthlessness of the materials of which it is made, and the purposes, useful, ornamental, and which it subserves, may be regarded as the most important of inventions. The of its discovery is involved in great obscurity; but if we believe Pliny, we are indebted for it to the Phœnicians—his tale being that a merchant-ship laden with natron (impure soda) having been driven upon the coast near the mouth of the river Belus in tempestuous weather, the crew were compelled to cook their victuals ashore; and having placed lumps of the natron upon the sand as supports to the kettles, found, to their surprise, masses of transparent stone among the cinders. But, be this as it may, the Egyptians were certainly acquainted with the art of glass-making; for in some nomes [NOME] glass beads have been found coloured with a metallic oxide, and pieces of glass have been discovered in the ruins of Thebes. (M. Boudet, *Desc. de l'Égypt*, vol. ix.; *Aul. Mémoires*.) In the time of Strabo and Pliny, the inhabitants of Sidon were famed for the production of beautiful glass, which they cut, engraved, and stained of the richest colours, in imitation of precious stones, and exported to all parts of the then civilised world. For a long time

Venice is said to have excelled all the countries of Europe in this manufacture; of which, indeed, it enjoyed a monopoly till about the middle of the seventeenth century. The period at which the manufacture of glass was introduced into England is not precisely known; but there can be no doubt that till near the close of the seventeenth century, this country was obliged to have recourse to foreigners for the supply of the common article of drinking glasses. In 1673, the duke of Buckingham materially improved the fabrication of British plate glass by bringing over several Venetian artisans to the works at Lambeth, which were under his patronage; and the manufacture was still further improved by the arrival of the French refugees after the revocation of the edict of Nantes. The above works, however, were soon abandoned; and it was exactly one century (1773) later that the first large establishment for the production of plate-glass was formed, under the title of 'The Governor and Company of British Cast Plate-Glass Manufacturers.' This company was incorporated by Act of Parliament, and soon after erected works on an extensive scale at Ravenhead near St. Helens, in Lancashire, which have continued in constant operation down to the present time. Since that period immense improvements have been made in the manufacture of every species of glass throughout all the countries of Europe.

Crown glass and flint glass have reached the highest perfection in England; in plate glass Great Britain is more than rivalled by France; while in glass for philosophical apparatuses, Germany and France are greatly in advance of this country. But although the French plate is superior to ours in quality, it is considerably higher in price. In fact, the great reduction that has been effected in the cost of this glass has, of late years, led to its largely extended use for window glass in Great Britain.

The application of glass to the glazing of windows is of comparatively recent introduction into dwelling-houses, though it was general in churches and other public buildings as early as the third or fourth century. In London, this manufacture was first begun in 1557; but that the use of window glass was by no means universal even twenty years later, is evident from the fact that at Alnwick Castle, the residence of the duke of Northumberland, the glass casements used at that period to be taken down in the absence of the family, to preserve them from accident. (*Domestic Architecture in England from Richard II. to Henry VIII.* part i. p. 121.) In Scotland, even in the early part of the last century, glass was seldom seen in the windows of country houses; and a few years previously, even in the royal palaces and the town houses of the nobility, the windows of the upper storeys alone were furnished with it. Since that period, however, a great change has been effected; for now even the windows of the meanest cottage are, almost without exception, supplied with glass, which ought rather to be considered as a necessary of life, than as the most elegant and useful of conveniences.

Composition and Manufacture of Glass.—Glass is essentially a compound of silica with potash or soda; other silicates, more especially those of lead and lime, being occasionally added. Transparency and insolubility in water are among the essential qualities of glass; but it should also resist the action of other solvents, such as acids and alkalies, and for many purposes it should not fuse or even soften at a red heat. The insolubility of glass depends much upon its aggregation, for if reduced to fine powder it reddens turmeric paper when moistened, and a portion of its alkali is frequently abstracted by long exposure to air and water; so also the glasses containing oxide of lead are readily discoloured by sulphuretted hydrogen, when in powder and diffused in water, although they long resist its action when in their ordinary state. The more fusible glasses, containing excess of alkali, of oxide of lead, or of lime, are also apt to be acted on by acids and alkalies, and are unfit for the retention of such solutions; and all glass is more or less disintegrated by the action of water at very high temperatures.

As the varieties of glass are mixtures rather than definite compounds of their component silicates, they scarcely admit of being represented by formulæ, though in some cases the proportion which the oxygen of the bases bears to that contained in the silica may be usefully stated. The large proportion of oxide of lead in *flint glass* gives it a high refractive power and brilliancy when cut, but renders it soft, easily fusible, and liable to be acted on by many chemical agents. In *plate glass* the predominance of silicate of soda gives a more liquid combination than potash, and enables it to be poured out of the crucible in which it is melted, upon a cast-iron table, and rolled into sheets, which, after careful annealing, are ground to a level surface with emery, and ultimately polished with colcothar. Large quantities of the waste and broken glass of former operations are frequently melted up (under the name of *cullet*) with the materials in the crucible. The remarkably tenacious viscidity of glass, when in a fit state for the operations of the glass-house, and the facility with which it is shaped, by blowing, moulding, and other manipulations, into its infinitely various forms, can only be understood by personal inspection.

The following table will give an approximate notion of the relative proportions of the components of several kinds of glass in common use:

	Plate	Crown	Flint	Bottle	Tube	Optical
Silica	78	63	52	59	73	43
Potash	2	22	14	2	12	12
Soda	13	..	..	10	3	..
Lime	5	12	..	20	11	..
Alumina	2	3	1	2	1	1
Oxide of Lead	..	..	33	..	..	44
Oxide of Iron	..	..	..	7	..	..
	100	100	100	100	100	100

A glass composed of borate and silicate of lead

has been used by Faraday for some optical purposes, and the borosilicate of zinc has been similarly applied by Maez and Clemandot.

All glass requires to be carefully *annealed*—that is, suffered to cool very slowly—otherwise it becomes liable to fly to pieces upon the slightest touch of any substance hard enough to scratch its surface. Small unannealed flasks, blown from samples taken from the pot, for the purpose of ascertaining the quality of the glass, and known in the glass-house under the name of *proofs*, well show this. When a fragment of flint is dropped into them they immediately crack; and if melted bottle glass be dropped into water, so as to form what are called *Rupert's drops*, the instant that their thin end is broken off they crumble into powder with a kind of explosion. This probably arises from the unequal tension of the layers of glass in consequence of the sudden cooling of the exterior, whilst the interior remains dilated, or even red-hot. When large masses of glass are slowly cooled, crystallised nodules are sometimes formed, more or less opaque, and embedded in the transparent glass. These appear to arise from the crystallisation of definite silicates.

When glass, embedded in sand, is heated up to a point a little below that of fusion, and allowed to cool slowly, it is converted into *Reaumer's porcelain*: it has become hard, white, opaque, and somewhat less fusible—changes which have been referred to the formation of certain definite crystallisable silicates, more especially those of lime and alumina. These phenomena of *devitrification* are best shown with common green bottle glass.

A peculiar glass is used for the manufacture of artificial gems, called *strass* or *paste*, containing a large quantity of oxide of lead, and frequently borate of lead. It is easily fusible, highly refractive, and very soft. [GEMS, ARTIFICIAL.]

The art of *colouring glass* depends upon its power of dissolving certain metallic oxides. The principal metals thus employed are: 1. *Gold*; it imparts various shades of red or pink, inclining to purple; 2. *Silver*; oxide, chloride, or phosphate of silver give a yellow colour; 3. *Iron*: The oxides of iron produce blue, green, yellow, or brown, dependent upon the state of oxidation and quantity. The protoxide gives various shades of green; the peroxide of brownish yellow; 4. *Manganese*: The protoxide leaves the glass colourless, but the peroxide gives it various tints of violet, and, if added in excess, renders it black. This oxide was formerly called *glass soap*, from its property of destroying the green tint communicated by protoxide of iron, derived from the use of impure materials; this it effects by converting the protoxide of iron into peroxide, which, in small proportions, does not materially affect the colour of the glass; whilst the peroxide of manganese, losing oxygen, becomes protoxide, and in this state is also not injurious. A little nitre is sometimes used for the same purpose; 5. *Copper*: the protoxide gives a rich green, and the dioxide a ruby red. The glittering appearance of *avanturin* glass is due to the dissemination of minute crystals of metallic copper, produced by the fusion of a mixture of iron and copper scales in the glass; 6. *Cobalt*, in the state of oxide, gives beautiful blues of all shades—in large quantity black; 7. *Chromium* produces greens and red, depending upon its state of oxidation; 8. *Uranium* is the source of the peculiar opalescent yellowish-green glass; 9. *Tin*, in the state of binoxide, gives the varieties of opalescent glass, terminating in opaque white *enamel*, in which there is also a little oxide of lead. An alloy of 1 part of tin and 2 of lead is calcined for the production of the oxides, and these are mixed with powdered glass. When surfaces are to be enamelled, this mixture is applied with a brush, and then fused by exposure to heat in a muffle. The colours used in enamel painting are derived from the metals above enumerated. A species of enamel is sometimes applied to iron saucepans and other vessels; it is a vitrifiable mixture of powdered flint with carbonate of soda, borax, and Cornish clay, with a little oxide of tin; this is brushed over the surface, then carefully dried, and heated in a muffle to bright redness; 10. *Arsenic*: Arsenious acid is much employed for giving an *opal* tint to glass. This glass is translucent, of a pale bluish-white colour, with a reddish hue when viewed in certain lights. On powdering this glass, and applying the usual tests for arsenic, the presence of this substance may be readily detected. Arsenious acid, in small quantity, by peroxidising iron, which usually gives a green tint, tends to render glass colourless.

Glass Gall. The saline scum which rises to the surface of fused glass in the glass pots; it is also called *sandiver*.

Glass Painting. The art of painting upon glass, with vitrifiable colours, in contradistinction to the use of coloured glass, in which the colour forms part of the composition of the glass itself. Remains of painted glass have been discovered in the ruins of the Assyrian, Egyptian, Greek, Etruscan, and Roman cities; but the introduction of painted glass, for windows, does not seem to have been practised generally till the twelfth century of the Christian era. From that period to the end of the sixteenth century, the art appears to have been cultivated with great splendour; it then began to decay, and it is only within thirty years that it has again recovered its hold upon public attention.

The ancient glass painting was generally executed in pieces of that material cut out to the shape of the colour which the artist wished to introduce, so that the windows resembled tables of mosaic work, in which there was no attempt at shading or modification of the tone. The colours used to form the ground of the pictures are the red, blue, and yellow; the two compound colours, the green and violet; the plain glass, and the slightly yellow, which being mixed with red yielded carnation; they

were sometimes shaded with brown, which seems to have been the only vitrifiable colour then known. Latterly, the artists have aimed at producing the effect of oil painting upon glass, and they have modified the system of employing the detached portions; they have shaded the whole of their compositions, and have thus materially diminished the effect of them. The old glass was always set in lead, which had a material influence upon the design adopted by the artists, because the setting defined the outline and limited the colours in a very distinct manner; this is not effected in the large paintings now executed, in which the artist is obliged to trust to the shadows, and to the variations of tint, for the definition of their outline; and the modern glass-painting lacks the sharpness and brilliant colour of the old precisely on account of this modification in detail. One great difficulty, however, attends every painting on glass, arising from the fact that the light being transmitted through the picture instead of being, as in oil painting, reflected from the surface, the artist is obliged to resort to a different set of principles to produce the effect. It requires, in fact, a distinct series of experiments before the method of obtaining the desired lights and shades with any peculiar colour can be ascertained; the depth of tone and the thickness of the glass must also be settled in this manner. We must not, however, forget, whilst discussing this branch of the subject, that the red glass used in the ancient windows is always double, or consists of white glass lined or coated with red. The mode of effecting this was by dipping the blow-tube into white glass in fusion, and subsequently into red, which was then blown into cylinders, and flattened.

There are two systems of painting on glass now used; the one consists of applying the colours with a water vehicle, somewhat in the same manner as water colours; the other consists in applying them with an essential oil vehicle, which does not evaporate so easily, and requires a higher temperature to fix the colours. Nearly all the English works have of late years been produced by the water-colour process, and they seem to have faded, at least when compared with the foreign works. One of the most successful specimens of modern glass painting is the decoration of the church of St. Vincent de Paul, in Paris; and among the most beautiful specimens of ancient art are the painted windows in the cathedral church of St. Michel and St. Gudule, at Brussels.

Four kinds of glass painting have been practised in England from the eleventh century; the first was the mosaic, in which white or stained glass only was used, such designs as were required being hatched and smeared on the pot-metal, in enamel brown; this method is described by Theophilus: the flesh was of a tan colour; the ornaments were commonly taken from the illuminated MSS. (See Theophilus, *Diversarum Artium Schedula*, or the translation of Robert Hendrie, *An Essay upon various Arts &c.* London 1847.) In the fourteenth century a great advance was made, so that various colours could be got on the same piece of glass, by means of a yellow stain from calcined silver on white or coloured metal; ruby was always coated. During this century and the following, the flesh is generally white, and the hair yellow—this was the mosaic-stain method. In the sixteenth century enamel painting was introduced, in which ordinary enamel colours were painted on white glass; giving two additional methods, the pure enamel, and the mosaic enamel, i.e. when coloured pot-metal was used instead of the white to paint on. There are thus four distinct methods of glass painting, the *mosaic*, the *mosaic stain*, the *enamel*, and the *mosaic enamel*, the last being the ordinary method of the present day, though the Sèvres painters still produce pure enamel paintings. William of Marseilles (1475–1537) has the credit of having been the first distinguished enamel painter on glass, and he is also said to have introduced the method of *abrasion*, producing a variety of effects by partially rubbing off the coat from coated glass. Norman and early English windows are *mosaic*; in Gothic work the *mosaic stain* prevails; and in Renaissance and Cinquecento glass, the *enamel* and *mosaic enamel* are the exclusive methods applied. There is a method now in practice of embossing or etching glass by means of asphaltum and fluoric acid; light and shade may be effected by this process, by graduating the *biting in*. (Lasteyrie, *Histoire de la Peinture sur Verre &c. en France*, Paris 1838; *An Inquiry into the Difference of Style in Ancient Glass Painting*, by an Amateur, Oxford 1847; Mrs. Merrifield's *Original Treatises &c.* London 1849; Gessert, *Rudimentary Treatise on Painting on Glass, &c.* London 1851)

Glass, Soluble. When glass is fused with excess of potash or soda, compounds are obtained which are more or less soluble in water, and have been applied to various useful purposes. When 8 parts of dry carbonate of soda, and 15 parts of white sand or powdered flint are fused together, a glass is obtained which is soluble in about 6 parts of boiling water. This solution has been used to arrest the decay of some building stones, and also for the purpose of diminishing the combustibility of wood, canvas, and similar materials, and more especially of theatrical scenery; it prevents its burning with flame, by forming a glaze upon the surface.

Glass for Telescopes. Till lately, English artists had failed in producing large discs of glass for the formation of object-glasses for telescopes; all the large object-glasses in the public and private observatories being of foreign manufacture. Since the duty has been taken off glass, considerable energy has been shown in England with respect to this branch of manufacture; and Messrs. Chance & Co. of Birmingham have succeeded in manufacturing a disc of pure glass twenty-nine inches in diameter,

whose thickness was two and a quarter inches, and weight 200 lbs. This disc was produced at the Great Exhibition of 1851, and was subjected to a very severe examination for the purpose of detecting defects arising from striæ, tension arising from imperfect annealing, bubbles, &c. The only serious defect which was detected after a very lengthened examination, was the existence of a group of striæ occupying a space of about six inches and a half in length, and two inches and a half in breadth, beginning at about one inch and a half from the edge, and having its longer dimension directed towards the centre. It was found that if it were ultimately thought necessary to sacrifice the defective portion, a disc of absolutely pure glass of at least twenty-two inches, or probably even of twenty-five inches in diameter, would still be left.

Glassites. [SANDEMANIANS.]

Glauber Salt. The name given to sulphate of soda, in honour of the German chemist Glauber, by whom it was made by the action of oil of vitriol on common salt; he called it *sal mirabile*. This salt also exists native, when it forms efflorescent crusts of a greyish or yellowish white colour.

Glauber's Secret Sal Ammoniac. Sulphate of ammonia; a salt first described by Glauber.

Glauberite. A native double sulphate of lime and soda, occasionally associated with rock salt.

Glaucine. A crystalline salifiable alkaloid, occurring in the leaves of the *Glaucium luteum*.

Glaucolite (Gr. γλαυκός, *azure*, and λίθος, *a stone*). A blue-green mineral from near Lake Baikal, in Siberia: it is a silicate of alumina, lime, and potassa.

Glaucoma (Gr. from γλαυκός). A disease of the eye, supposed to arise from dimness of the vitreous humour, and giving it a bluish green colour.

Glauconite (Gr. γλαυκός). A constituent of the *greensand* formation; it is also sometimes found in the cavities of certain trap-rocks. Under the name of *green-earth* it is used as a pigment. It is a hydrated silicate of iron and alumina with a variable amount of alkalies.

Glaucopicrine (Gr. γλαυκός, and πικρός, *bitter*). An alkaloid occurring with *glaucine* in the *Glaucium luteum*.

Glaucopis (Gr. γλαυκῶπις, *grey-eyed*). A genus of Passerine birds established by Forster, and including certain species remarkable for the presence of fleshy wattles attached to the base of the beak; whence they are commonly termed *wattle-birds*. Temminck characterises the genus as follows: Bill moderate, strong, and thick, with the base enlarged towards the commissure; upper mandible convex, vaulted, curved towards the end, and without any notch; lower mandible following the curvature of the upper, straight below, hidden in part by the sides of the upper mandible. Nostrils basal, lateral, round, partially closed by a large membrane, and entirely hidden by curled feathers advancing from the forehead. Feet robust, the tarsi longer than the mid-toe; toes nearly of the same length; the base of the inner toe, and nearly the whole of the outer toe, attached to the middle toe. Wings short; the first quill short, the three following graduated, and the fifth the longest. Tail long and graduated.

Glaucous (Gr. γλαυκός). In Botany, sea-green; a term used in describing the colour of bodies, to denote a dull green passing into blue. Also used in describing the polish of bodies, to denote their being covered with a fine bloom of the colour of a cabbage leaf. *Glaucescent* is the diminutive of this.

Glaucus. In Greek Mythology. [SARPEDON.]

GLAUCUS. In Zoology, the name of a genus of Nudibranchiate Molluscs, remarkable for their beautiful azure tint. The species of *Glaucus* are found in the warmer latitudes floating in the open sea.

Glaze (another form of the word *glass*). The operation of covering earthenware or porcelain with a coating of vitrified matter is called *glazing*. It usually consists of oxide of lead, salt, or pulverised felspar, according to the nature of the base; the lead glaze being used for earthenware and pottery; the salt glaze, for the commoner descriptions of stoneware; and the felspar glaze for porcelain or china. [GLASS; POTTERY.]

Gleaning (Fr. glaner). The practice of collecting corn left in a harvest field after the harvest has been carried. The Levitical law (Lev xix.; Deut. xxiv.) ordained that the corn so left should be for the poor. The right of the poor to glean is, however, not admitted in the English common law.

Glebe (Lat. gleba, *arable soil*). In Law, church land; usually taken for that which is annexed to a parish church of common right, and belongs to the parson or vicar.

Glechoma (Gr. γλήχων, *a sort of thyme*). The Linnæan name for the wild plant now more usually called *Nepeta Glechoma*, and known under the popular name of Ground Ivy. It furnishes a favourite popular remedy for coughs.

Glee (A.-Sax. glig, gliw, *music, sport*). In Music, a composition for voices in three or more parts. The subjects of the words are various, being gay, grave, amatory, pathetic, or bacchanalian. It may consist of only one movement, but usually has more.

A glee is distinguished from a madrigal, in that the former is sung with one voice only to a part, but the latter with several, like a chorus.

Glee-man. Itinerant minstrels were so called by the Anglo-Saxons; by the Latin writers of the middle ages they are termed *joculatores*. The name appears to have been supplanted by the Norman *minstrel*, shortly after the Conquest.

Glenoid (Gr. γληνοειδής, *socket-like*). A term applied in Anatomy to certain articular surfaces of bones: thus the surface of the scapula which articulates with the head of the

humerus is called the *glenoid cavity* of the scapula or blade-bone. The same term is also applied to the surface which receives the articular head of the lower jaw.

Gliadine (Gr. γλία, *glue*). A chemical term applied to one of the constituents of the gluten of wheat.

Glires (Lat. pl. of glis, *a dormouse*). The Linnæan name of the order of Mammalia distinguished by two long chisel-shaped incisors in each jaw. [Rodentia.]

Globe (Lat. globus). A round body, or sphere; a term commonly applied to the earth. The term *artificial globe* is more particularly used to denote a globe of metal, plaster, paper, &c., on the surface of which a map of the earth or of the celestial constellations is delineated, with the principal circles of the sphere. In the former case it is called the *terrestrial*, in the latter the *celestial globe*. Artificial globes are used for the purpose of conveying to children the first ideas of the figure and rotation of the earth, of latitude and longitude, and the situation of places with respect to each other, and to the sun at the different seasons of the year. It is usual to employ them also for the purpose of solving mechanically a few elementary problems of astronomy, relative to the difference of the hour of the day at different places, the times of the rising and setting of the sun, the limits of the visibility of eclipses, &c.

Globular Chart. A delineation, on a plane, according to the method of *globular projection*, of any part of the earth's surface. The method was proposed by Lahire. [Map; Projection.]

Globular Sailing. [Great Circle Sailing.]

Globulariaceæ (Globularia, one of the genera). A small natural group of shrubby or herbaceous perigynous Exogens, inhabiting the hot and temperate parts of Europe, combined by Lindley with the *Selaginaceæ*, an order of the Echial alliance. Their sensible properties are bitter tonic and purgative.

Globuline. A term given by Kieser to the green globules lying amongst the cells of cellular tissue. This word has been applied by Turpin, a French phytotomist, to all minute vesicular granules of a vegetable nature, which he considers the organic elements of vegetation. It is either cellular or vesicular tissue in a young state and disintegrated, or granules of starch, or particles of colouring matter collected into microscopical balls. The term *globuline* has also been applied to a modification of albumen found in the humours of the eye, and by some physiologists to the colourless part of blood corpuscles.

Glochis (Gr. γλωχίς, *a projecting point*). A form of hair occurring in plants, forked at the apex: a *barb*.

Glory (Lat. gloria). In Painting and Sculpture, a nimbus or circle, either plain or radiated, surrounding the heads of saints, &c. It was used by the Greeks and Romans for the heads or statues of divinities or deceased emperors. [Aureola.]

Gloss (Gr. γλῶσσα, *tongue*). In the *Rhetoric* of Aristotle, this word is used in the sense of a foreign, obsolete, or otherwise strange idiom; which, when judiciously employed, he reckons among the ornaments of style. From the sense of 'something requiring interpretation' the word came to mean the interpretation itself; strictly, of a single word or phrase. In the twelfth century, the comments or annotations of learned jurists on passages in the text of the Roman law were denominated *glosses*; when these extended to a running commentary, they were termed an *apparatus*. The glosses were collected by Accursius in the thirteenth century, and from that period they formed for a long time a body of authority reckoned equal or even superior to the text itself.

Glossary (Lat. glossarium). A dictionary of difficult words and phrases in any language or writer; sometimes used for a dictionary of words in general. Of all the works published under the title of *glossary*, the most celebrated is the *Glossarium Mediæ et Infimæ Latinitatis* of Ducange. The best edition of this great work is that by Carpentier, in 6 vols. folio, 1733—1736. Carpentier's *Supplement*, in 4 vols. folio, 1766, is an indispensable addition.

Glossopetræ (Gr. γλῶσσα, *tongue*, and πέτρα, *rock*). The fossil teeth of certain fishes.

Glottalite (from *Glotta*, the river Clyde). A white mineral from the vicinity of Glasgow. It is a hydrated silicate of lime and magnesia.

Glottis (Gr. γλωττίς). The superior opening of the larynx or windpipe.

Gloves (A.-Sax. glof). Well-known articles of dress used for covering the hands. The practice of covering the hands with gloves has been almost universal from time immemorial. In the middle ages, gloves constituted a costly article of dress, being often highly decorated with embroidery and precious stones. In the age of chivalry it was usual for the soldier who had gained the favour of a lady to wear her glove in his helmet; and, as is well known, the throwing of a glove upon the ground was the most usual mode of challenging to duel. This latter practice prevailed as early as the year 1245.

Glow-worm. [Lampyris.]

Gloxinia (after Dr. Gloxin, a botanist of Colmar). Among the more popular of hothouse flowers are the many forms of this genus of *Gesneraceæ*, well known to gardeners by their foxglove-shaped flowers of varied colours each standing on a separate stalk—in some forms with the opening of the tube directed downwards; in others (which have originated in a freak of nature) standing erect. These plants are among those which generate buds from fragments of their leaves, under the hands of the cultivator.

Glucic Acid. *Kalisaccharic acid.* A body formed by the spontaneous decomposition of combinations of grape sugar with alkalies.

(Gr. γλυκύς, from the sweet taste of its salts). The metallic base of the earth glucina, discovered by Vauquelin in

1798, and hitherto only found in a few rare minerals. The metal, which is of a dark grey colour, was first obtained in 1828 by Wöhler; he procured it by acting upon the chloride of glucinum by potassium. The equivalent of glucinum is 7, glucina being represented as a sesquioxide $= G_2O_3$.

Glucose. [GRAPE SUGAR.]

Glucosides (Gr. γλυκύς). Natural combinations of grape sugar with other neutral organic bodies.

Glue (Gr. κόλλα, Lat. gluten). Glue is prepared from the clippings of hides, hoofs, &c. These are first washed in lime water, and afterwards boiled and skimmed; the solution is then strained through baskets, and gently evaporated to a due consistency; then cooled in wooden moulds, cut into slices, and dried upon nets. Good glue is semitransparent, deep brown, and free from spots and clouds. When used, it should be broken in pieces, and steeped for twenty-four hours in cold water, which causes it to soften and swell; the soaked pieces are then melted over a gentle fire, or, what is better, in a water bath, and in that state applied to the wood by a stiff brush. Glue will not harden in a freezing temperature, the stiffening depending upon the evaporation of its superfluous water. The chemical properties of glue are those of an impure *gelatine*.

Glume (Lat. gluma, *the husk* of corn). In Botany, the exterior series of the scales which constitute the flowers of grasses. The inner series, commonly called *pales* or *paleæ*, are sometimes called *Glumellæ*, and the term *Glumellulæ* is applied to the hypogynous scale found in the flowers of this tribe of plants.

Glut. In Political Economy, such a production of any commodity as is temporarily in excess of the demand.

It is the object of every producer to anticipate the demand for his product; and, as a rule, supply and demand coincide. But there may be, and constantly are, errors in calculation inducing an over-production of some manufactured or accumulated commodity; or the seasons may be so favourable as to induce a large depreciation in the value of existing stocks, and even to lower the prices of articles below the ordinary cost of producing them. Such occasional circumstances are more likely to arise when any hindrance is put upon the natural tendencies of the market, or when the anticipations of the producer are made difficult by legislative acts, such as protective measures, prohibitions and taxes on exportation, bounties and the like.

Over-production cannot be general, but only special. If everyone produced more, everybody would purchase more, and matters would by this very fact be righted. Indeed, the tendency of mechanical and agricultural improvement is to induce greater general productiveness, and thereupon to bring commodities more and more within the reach of consumers. The dread, therefore, of what has been called a *general glut* is wholly irrational, though it has often induced hasty legislative action, and serious loss to those whom the administration has attempted to assist. Nor can a special glut last long. Persons will not long produce at a loss. The capital which had previously been diverted into unprofitable channels is directed to other employments, and comparative scarcity restores prices. There is obviously a tendency towards equal profits in all occupations; and if action be free, no calling can appropriate exceptional advantages. A fallacy in terms similar to that of general gluts, is contained in the hypothesis of a general rise or fall in values. [VALUE.]

Gluteal (Gr. γλουτός, *the buttocks*). Of or belonging to the buttocks: as gluteal *muscles*, *arteries*, &c.

Gluten (Lat.). The viscid elastic substance which remains when wheat flour is wrapped in a coarse cloth, and washed under a stream of water, so as to carry off the starch and soluble matters. Gluten exists in many grains, and occasionally in other parts of vegetables; but it is a characteristic ingredient in wheat, giving wheat flour its peculiar toughness and tenacity, which particularly fits it for the manufacture of bread, and for viscid pastes, such as macaroni and vermicelli. There is generally more gluten in the wheat of warm climates than of cold; hence the excellence of wheat grown in the south of Europe for the manufactures just mentioned. Gluten contains nitrogen, and has consequently been called the vegeto-animal principle: it yields ammonia when subjected to destructive distillation, and the vegetables which contain it give out a peculiarly disagreeable odour during their putrefaction. Sulphur is also one of the ultimate components of gluten. Raw gluten appears to contain several azotised principles, such as vegetable fibrine, caseine, &c., but all closely allied in ultimate composition, which may be represented by—

Carbon	55
Hydrogen	7
Oxygen (and Sulphur) .	22
Nitrogen	16
	100

Gluteus (Gr. γλουτός, *the buttocks*). The large and thick muscle upon which we sit, and which serves to extend the thigh by pulling it directly backwards. It also assists in its rotatory motion.

Glutton (from the same root with Lat. glutio, *I swallow*, and gula, *the throat*, Sansc. gala). The name of a carnivorous plantigrade quadruped (*Gulo arcticus*); also applied by some micrographers to a diaphanous species of *Naïs*.

Glyceria (Gr. γλυκερός, *sweet*). A genus of Grasses found in wet situations, represented in our own Flora by *G. fluitans* and one or two other species. *G. fluitans* is called Ma Grass, and its seeds are collected in countries, and prepared for sale under the of Manna Croup.

Glyceric Acid (Gr. γλυκύς). A non-crystalline acid, produced by the action of nitric acid on glycerine.

Glycerine (Gr. γλυκερός). A sweet substance evolved in the process of saponification. It was originally observed in the formation of common plaster by boiling oil with oxide of lead and water. It has now become an article of commercial manufacture, and is used in certain pharmaceutical preparations: it is principally supplied by the wholesale manufacturers of stearine candles, who obtain it in large quantities as a product of the decomposition of fatty matters. It is represented by $C_6H_8O_6$.

Glyceryl. The radical of glycerine $= C_6H_7$.

Glycine (Gr. γλυκύς, *sweet*). A genus of *Leguminosæ* to which was formerly referred a very handsome woody creeper, much used for training on walls and houses, which it decorates in spring with its pendent racemes of lilac pea-shaped blossoms. This species, *G. frutescens*, is now called *Wistaria frutescens*.

Glycocoll (Gr. γλυκύς, and κόλλα, *glue*). *Glycocin*. A sweet crystalline body produced by the action of alkalies on gelatine.

Glycol. A sweetish viscid liquid soluble in water and alcohol. Its composition is $C_4H_6O_4$, so that it differs from alcohol in containing two more atoms of oxygen.

Glycolic Acid. A crystalline body derived from glycol by direct oxidation.

Glycyrrhiza (Gr. γλυκύῤῥιζα, *having a sweet root*). The Liquorice of the shops is the produce of a plant of this genus of *Leguminosæ*, called *G. glabra*. It is a strong-growing plant, with thick deeply-penetrating roots, from which the demulcent extract is obtained by slicing the root, boiling it in water, and straining and evaporating the liquor. The prepared extract is popularly called Spanish Liquorice, from its being largely imported from Spain. In Italy it is prepared from an allied plant, *G. echinata*.

Glycyrrhizin. The peculiar saccharine matter of the root of *Glycyrrhiza glabra*, or common liquorice.

Glyph (Gr. γλυφίς, *a notch*). In Architecture, a vertically sunken channel. From their number in the Doric order, they are called *triglyphs*.

Glyphography (Gr. γλύφω, *I engrave*, and γράφω, *I draw*). A method of engraving, by which drawings are made through a thin whitened wax ground laid on a blackened copper plate, the thickness of the wax ground forming the depth of the engraving.

Glyptic (Gr. γλύφω). In Sculpture, a term denoting the art of carving in stone or any other hard substance.

Glyptodon (Gr. γλυπτός, *carved*, and ὀδούς, *a tooth*). The name of an extinct gigantic quadruped belonging to the family of Armadilloes (*Dasypodidæ*), and covered, like them, with a tesselated osseous armour. It is distinguished from the existing armadilloes not only by its size, which equals that of the rhinoceros, but by its teeth, which are longitudinally fluted, whence its generic name.

Glyptotheca (Gr. γλυπτός, and θήκη, *a store*). A building or room for the preservation of works of sculpture; a word adopted by the Germans, as in the instance of the celebrated Glyptothek at Munich, constructed for the late king of Bavaria, Ludwig I., by Leo von Klenze, in 1816–30. It is profusely decorated with frescoes by Peter von Cornelius.

Gmelinite. A hydrated silicate of alumina, potash, and peroxide of iron; named after Gmelin, the mineralogist. It has also been called *Hydrolite*, from the quantity of water which it includes.

Gnaphalium (Gr. γναφάλιον). The plants of this genus of *Compositæ* are amongst those called *Everlastings*. It formerly included most of those met with in gardens; but they are now distributed in several other genera, of which the principal are *Helichrysum* and *Antennaria*.

Gnat. [CULEX.]

Gnathidia (Gr. γνάθος, *a jaw*). A technical term in Ornithology for the lateral parts or rami of the mandible or lower jaw, which are joined to the cranium behind, and meet in front at a greater or less angle.

Gnathotheca (Gr. γνάθος, and θήκη, *a sheath*). In Ornithology, the horny or cutaneous integument of the beak.

Gnawers. In Zoology. [RODENTIA.]

Gneiss (Ger.). Gneiss is generally described as stratified granite It is, in fact, composed of the same materials as granite, namely, quartz, felspar, and mica; but instead of the mass being a multitude of crystals embedded in a base, the whole being compact and possessed of neither cleavage nor foliation, it is, on the contrary, arranged in parallel plates, almost like strata. Gneiss varies exceedingly in its mechanical state, and admits of great modifications, consistent with its metamorphic origin.

Gneiss, when the mica is abundant and the felspar rare, often passes into *mica schist* or *mica slate*, which consist theoretically of mica and quartz alone. The difference between true gneiss and the two rocks thus named is neither very considerable nor very clear. One passes into the other. The whole group of schistose rocks must be regarded as, to some extent, related; and the following illustrations are sufficient to make this clear.

Gneiss and mica-slate often form mountain masses in association with each other and with the varieties of granite. The former is seen singularly contorted upon the coast of Lewes; and mica-slate rock is associated with the serpentine of Cornwall, and is seen in great perfection among the Scotch granitic scenery, more especially in the vicinity of Dunkeld, and in extraordinary magnificence in the lofty mountain of Benmore. Ben Lawers, on the north of Loch Tay, and many of the neighbouring mountains, furnish highly instructive specimens of granite passing into gneiss, mica-slate, and chlorite-slate. About three miles south of Dunkeld, stratified rocks may be seen incumbent upon chlorite-slate, gradually passing into a

fine grey roofing slate, and this recumbent upon mica-slate. The peculiar and differing dip of the respective strata, the singular manner in which they are pierced and traversed by veins of felspar and quartz, and their association with micaceous iron, are circumstances highly interesting in respect to the origin of hypogene rocks; and the beauty and magnificence of the district in regard to scenery is not less than its diversified geological peculiarities.

Gnetaceæ (Gnetum, one of the genera). One of the few orders of Gymnogenous plants commonly called Joint Firs; *Ephedra*, one of the genera, consisting of jointed plants, with the aspect of *Equisetum*, but of a woody character. The order has been known generally by its stems being jointed at every node; but latterly the curious *Welwitschia mirabilis* has been associated with it, and in this there is only a short thick table-like trunk or stem, with a fungoid upper surface, and a pair of long simple leaves, produced at the time of germination, and remaining alone through the life of the plant. There is a branched inflorescence bearing cones, arising from the truncated upper part of the stem, which rises but a foot or two above ground, its two only leaves resting on the surface.

Gnome. A name given by the fanciful writers of the Cabalistic school to that class of elemental spirits which were said to inhabit the earth. Their name is more properly *Gnomons*, from the Greek γνώμων, *knowing, cunning*.

Gnomic Poets (Gr. γνωμικός, *dealing in maxims*). Greek poets, whose remains chiefly consist of short sententious precepts and reflections, are so termed in classical bibliography. The principal writers of this description, of whom a few fragments are extant, are Theognis and Solon, who lived in the sixth century before the Christian era. With them Tyrtæus and Simonides are joined by Brunck in his edition (*Poetæ Gnomici Græci*, Argent, 1784), although these writers have little of a gnomic character. The metre of these poets is elegiac.

Gnomon (Gr. γνώμων). In Dialling, the style whose shadow marks the hour; generally it denotes a rod or pillar from whose shadow the altitude or position of the sun may be determined. Gnomons were probably the first astronomical instruments; and they appear to have been much in use among the Egyptians, the Chinese, and even the Peruvians. (Goguet, *Origine des Loix.*) It is evident that observations of this kind cannot give the sun's altitude with much exactness. The shadow is never so well defined that its limits can be ascertained with astronomical precision; besides, the observation requires to be corrected for parallax, refraction, and the sun's semidiameter—elements which can only be determined by means of instruments of a very superior description to the gnomon, and which, consequently, render the latter useless. The astronomer Ulug-Beg, about the year 1437, erected a gnomon at Samarcand, the height of which was 165 Paris feet.

In Geometry, a gnomon signifies the part of a parallelogram which remains when one of the parallelograms about its diagonal is removed; or the portion of the parallelogram composed of the two complements and one of the parallelograms about the diagonal. The term is seldom used, except in Euclid's *Elements*.

Gnomonic Projection. [PROJECTION.]

Gnomonics. The art of constructing dials. [DIAL.]

Gnosticism (Gr. γνωστικός, from γνῶσις, *knowledge*). A philosophical system of religion which prevailed in the East during the four first centuries of our era, and exercised great influence upon Christian theology, giving birth to numerous heresies, and insinuating itself even into the writings of the most orthodox fathers. In its leading principles this system seems to point to the Oriental philosophy as its genuine parent; but it is objected to this solution that the fathers refer it, together with the errors similarly introduced by Platonism, to a Greek origin, and appeal to the cosmogonies of Hesiod and others as the real exemplars from which it is imitated. It is to be remarked, however, that the fathers were universally ignorant of the Oriental philosophy; from which we may conclude that their opinion upon such a point is not necessarily decisive. A modern solution conceives Alexandria to have been the central point to which the speculations of the Greeks and the Orientals converged, and from which they frequently reissued, after having undergone the process of fusion into a common mass. But although it is certain that Alexandria was, during the time we have spoken of, a celebrated resort of Gnostic opinions, both within and without the church, the close agreement of the leading principles of Gnosticism with those of the Zoroastrian philosophy seems to point to a common tradition, at once very ancient and very widely spread.

The grand principle of this philosophy seems to have been an attempt to reconcile the difficulties attending upon the existence of evil in the world. Evil, it was supposed, being the contrary of good, must be contrary to, and therefore the opponent of, God: if the opponent of God, then independent of Him and coeternal. From the many imperfections which are involved in all outward and sensible objects, it was held that matter must contain in itself the principle of all evil. The human soul, on the contrary, which aspires after and tends to a higher and more perfect developement, was held to be the gift of the Supreme Deity, imparted to man for the sake of fighting against the material principle, and with the prospect of finally subduing it. From the Supreme God on the one hand, and matter on the other, succeeding philosophers produced various fanciful genealogies of superior intelligences, under the name of Æons—a Greek word signifying properly periods; thus representing these divinities themselves by a name expressive of the time and order of their generation. The Demiurgus,

who formed the world out of matter, appears to have been an Æon derived from the evil principle. He was also the God of the Old Testament, who was considered by the Gnostics to be an object of aversion to the One Supreme God, to counteract whose machinations the Æon Christ was sent into the world. This is the earlier and simpler system, which is attributed to Simon Magus: the number of the Æons was fancifully multiplied in later times, and an extravagant theory of morals founded upon the system. The object of these principally was, as may be supposed, to depreciate the honour due to the body, as being a part of matter, and to elevate the thinking faculty, or at least to remove it from all consideration of worldly things. The Gnostics imagined that by assiduous practice of certain mental and bodily austerities they could obtain an intuition of the divine nature, and dwell in communion with it; and this part of their system is adopted to a considerable extent by Clemens Alexandrinus, whose opinions, as expressed in his *Pædagogus*, are very similar to those of a Pietist of more modern times.

The Gnostics split in process of time into various sects, distinguished rather by their different cosmogonies than by any variation in principle. Of these the principal were founded by Carpocrates, Basilides, Tatian, and Valentinus. The system did not survive the fourth century, although its spirit continued for some time longer to colour the Christianity of the East. The Christians seem sometimes to have adopted the general designation of Gnostics. (Burton's *Bampton Lectures*; Neander; Gieseler, *Text-book of Eccl. Hist.*; Riddle's *Christian Antiquities*; E. Bunsen, *Hidden Wisdom of Christ*; King's *Gnostics and their Remains.*)

Gnu. The *Antilope Gnu* of Linnæus, a large bovine antelope, which is found in herds in the arid deserts near the Cape of Good Hope. Three species are known.

Goat (Old Norse, geit). The English name for the well-known ruminant of the genus Capra. The goat is characterised by its long horns, which are rounded posteriorly, angular on the anterior edge; transversely rugose, rising at first perpendicularly, afterwards bending outwards and a little backwards. It is clothed by long hair, which, in the Cashmere breed, is soft and fine, and forms the staple of the celebrated shawls of that name. Beneath the long hair is a soft wool. The female produces two kids at a birth, which derive their nourishment from two teats supported on a large pendent udder. The period of gestation is five months. The milk of the goat is regarded as more easily digestible than that of the cow, and therefore better adapted for the weak and consumptive. The flesh of both the goat and kid is much esteemed in many countries, though it has a peculiar flavour, arising, it is said, from the shrubs and heaths on which they browse. In Portugal and other countries, the goat is used as a beast of draught.

Goat-sucker. The *Caprimulgus europæus* of Linnæus, a small passerine bird, more correctly termed the Nightjar. [CAPRIMULGUS.]

Gobbing. In Mining, the refuse thrown back into the excavations remaining after the removal of the coal.

Gobelin Tapestry. A species of tapestry, so called after Giles Gobelin, a well-known French dyer in the reign of Francis I. His house in the suburb of St. Marcel in Paris is still called the Gobelins. A manufactory for tapestry was established in this quarter by Colbert in 1666.

Goby. A genus of osseous fishes (*Gobius*), allied to the cod. The three-spined goby, common in England, is an example.

Godbold's Vegetable Balsam. A quack remedy composed, according to Dr. Paris (*Pharmacologia*), chiefly of honey and vinegar.

Godfather and Godmother. [SPONSORS.]

Godfrey's Cordial. A quack medicine made by infusing 9 ounces of sassafras shavings and of bruised caraway, coriander, and anise seeds each 1 ounce, in 6 pints of water, simmering the mixture till reduced to 4 pints, then adding 6 pounds of treacle, boiling for a few minutes, straining, and adding lastly 3 ounces of tincture of opium. It is often administered as a sedative to children, but is highly dangerous from the opium which it contains.

Godroon. In Architecture, an inverted fluting, beading, or cabling, used in various ornaments or members.

Godwit. [LIMOSA.]

Gog and Magog. The names of two symbolical warriors noticed in some books of the Old Testament (Gen. x., Ezekiel xxxviii. &c.). Since the Christian era they have been regarded as nearly synonymous with Antichrist. The author of the Apocalypse (xx. 8) uses the terms to express the nations hostile to Christianity; and Mohammed, in the Koran (21, 96), employs them in an analogous sense, to denote the enemies of Islam. (For the imaginary rampart of Gog and Magog, see Gibbon's *Roman Empire*, ch. xl.) The names Gog and Magog are given to two huge warlike figures which adorn the Guildhall of London.

Goître. [BRONCHOCELE.]

Gola or **Gula.** In Architecture, the same as CYMA [which see].

Gold (Ger.). This metal has been known from the remotest ages: it is the *Sol* of the alchemists, who represented it by the circle ⊙, the emblem of perfection: its symbol is Au. (*aurum*). It occurs in nature in a metallic state alloyed with silver or copper, and is called *native gold*. It is found disseminated in primitive or igneous rocks, or in the beds of rivers, and in alluvial deposits. The largest supplies have been derived from Australia and California; from Brazil, Mexico, and Peru; from the Ural Mountains; and from some parts of Africa. The rivers of Hungary, Transylvania, and Piedmont have also yielded the metal; and it has been found in Cornwall, Wicklow, and North Wales. Though it generally occurs in small nodules and granules, *nuggets* are some-

times found weighing many pounds. It is usually separated from the matrix by grinding and washing, or by amalgamation with mercury.

Gold is of a peculiar yellow colour. It melts at a bright-red heat, equivalent to about 2,000 of Fahrenheit's scale, and when in fusion appears greenish; as it solidifies, it contracts in bulk. Its specific gravity, in its least dense state, after fusion, is 19·2; by hammering and rolling it may be brought up to 19·3 or 19·4. It is so malleable, that it may be beaten into leaves which do not exceed the $\frac{1}{200000}$th of an inch in thickness; a single grain may be extended over 56 square inches of surface; and it is so ductile that a grain may be drawn out into 500 feet of wire. It may be kept for several hours in fusion without perceptible loss of weight; but when subjected to an intense heat, it affords evidence of volatility. The concentrated mineral acids have separately no action upon pure gold; neither has sulphur nor sulphuretted hydrogen. Chlorine, iodine, and bromine, on the contrary, act upon it; the ... nt commonly resorted to for dissolving it is chlorine, generally in the form of nitrohydrochloric acid, or *aqua regia* If a small portion of leaf-gold is added to a freshly-made solution of chlorine, and the mixture heated, the gold is dissolved, forming a yellow-coloured liquid, any silver that may have been present remaining undissolved. The equivalent of gold is 197; it forms a *protoxide*, $=$Au O, and a *peroxide*, $=$Au O_3, and there are two corresponding *chlorides*. The *aurocyanide of potassium*, obtained by dissolving cyanide of gold in a solution of cyanide of potassium, is used for gilding silver and copper, and especially for electroplating.

Of the *alloys of gold*, those with copper, mercury, and silver are the most important. With *copper* gold forms a ductile alloy, of a deeper colour, harder, and somewhat more fusible than pure gold. This alloy, in the proportion of 11 parts of gold to 1 of copper, constitutes our *standard gold*; its specific gravity is 17·167, being a little below the mean. One troy pound of this alloy is coined into $46\frac{29}{40}$ sovereigns, or 20 troy pounds into 934 sovereigns and a half. The pound was formerly coined into 44 guineas and a half. The standard gold of France consists of 9 parts of gold and 1 of copper. Standard gold is not affected by nitric acid; but the inferior alloys which are made to imitate gold, consisting chiefly of copper and zinc, immediately decompose it, and set free deutoxide of nitrogen. In testing small articles of jewellery, the metal may be rubbed upon a surface of flint, basalt, or jasper, so as to transfer a portion to the stone. One or two drops of nitric acid are then placed on the metallic streak. If the article is a base alloy, the metallic appearance is speedily destroyed, and dissolved: if gold, it remains unaffected. Base alloys are frequently plated with gold, and in this case the best method of judging of their quality is by taking the specific gravity, which should be at least 17 for *standard gold*. Trinket gold is seldom above 15; and the so-called gold chains, ordinarily met with, vary from 11 to 13. Common gilt articles vary from 7 to 9. *Mercury* and gold combine readily, especially when heated. When rich in gold, the amalgam is of a buttery consistence, and may be separated from the more liquid portion by pressure through leather; it then consists of about two parts of gold and one of mercury: the amalgam used for gilding bronze contains about one-eighth of gold. *Silver* and gold mix readily when the fused metals are stirred together. The standard gold at present coined is for the most part alloyed with copper only; previous to the year 1826, the alloy consisted in part of silver, hence its paler colour. To separate the silver from gold, the alloy is melted with a great excess of silver, granulated, and boiled in sulphuric acid, by which the silver is oxidised and converted into sulphate, the metallic gold remaining in the form of a dark insoluble powder, which is afterwards collected, washed, and fused into a button or ingot. In the same way, the small quantity of gold contained in silver coin, which used to pass unheeded, is extracted by sulphuric acid; the recently coined silver will accordingly be found, in most cases, destitute of those traces of gold which are contained in our coin of a date anterior to 1826. When gold and silver are parted by the action of nitric acid, it is necessary, as in the case of sulphuric acid, that the silver should be in great excess; it is otherwise protected by the gold from the solvent power of the acid.

Assay of Gold.—The quantity of standard or other gold used for assay is generally about 8 grains: to this, about three times its weight of pure silver, together with the proper proportion of lead, is added, and the whole subjected to *cupellation*. [CUPEL; LEAD.] The silver and gold are thus thoroughly combined, while the oxides of lead and copper are absorbed by the cupel. The auriferous button is then flattened under the hammer, and after having been annealed, is passed between a pair of small rollers, so as to extend it into a thin riband: it is then again annealed, and coiled up so as to form what is called a *cornet*, which is put into a flask containing about an ounce of hot nitric acid, sp. gr. 1·180, and boiled for about ten minutes, by which the silver is dissolved, and the gold, retaining the form of the cornet, remains: this is again boiled for about twenty minutes in somewhat stronger nitric acid, and then carefully washed and transferred to a small crucible, in which it is heated to redness. When cold, the loss upon the original weight of the sample is carefully ascertained. The weight of the alloy operated upon is generally represented as $=$1,000, and the weights used are so adjusted as to give the value of the alloy in thousandths. In the process of gold-assaying, as in that of silver, various errors have to be compensated for, more especially in reference to the traces of copper, lead, and silver which may have been left in the gold.

Tests for the Salts of Gold.—Such of these

are soluble are distinguished by the peculiar purple precipitates which they afford with the mixed chlorides of tin. Protosulphate of iron, and oxalic and sulphurous acids throw down metallic gold. They are all decomposed by heat, and the residuary gold is easily recognised.

Gold Fish. The *Cyprinus auratus* of Linnæus, a Chinese species of carp, which has been naturalised in our artificial waters.

Gold Leaf. [Gold.]

Goldbeater's Skin. The membrane used by goldbeaters, and interposed between the leaves of gold when they have attained considerable tenuity; the intestinal membrane of the rectum of the ox is generally used.

Golden Fleece. [Argonautes; Fleece, Golden.]

Golden Number. [Cycle.]

Golden Rod. A common garden name for the species of *Solidago*.

Golden Rule. In Arithmetic, synonymous with the Rule of Three. The term is now rarely used.

Goldfinch. The common name of our well-known and brightest-plumaged songster; the *Carduelis elegans* of most modern ornithologists, *Fringilla Carduelis* of Linnæus. This species feeds chiefly on the seed of the thistle and plantain; but builds its nest, which is of the neatest construction, in the fork of a branch of some densely-leafed tree, and lays four or five eggs, of a bluish white, spotted with brown at the greater end. The female is less brightly clad than the male, and the young have a comparatively simple plumage, in which brown predominates.

Golf. A game with a ball and clubs, almost peculiar to Scotland, where it enjoys a degree of popularity equal to cricket in England.

Gomarites. In Ecclesiastical History, the Calvinist divines of the church of Holland in the seventeenth century were so called, from Francis Gomar, a colleague and opponent of Arminius at Leyden. [Arminians.]

Gomphiasis (Gr.). A disease of the teeth, when they loosen and fall out of the sockets. The grinding teeth are also called *gomphioi*.

Gompholite (Gr. γόμφος, *a nail*; λίθος, *a stone*). A term applied by Brongniart to the conglomerate rocks of the tertiary series, called by the Swiss *Nägelfloh*.

Gompholobium (Gr. γόμφος, and λοβός, *a pod*). This beautiful genus of Australian Leguminous shrubs has the unenviable notoriety, like its ally *Gastrolobium*, of being a sheep-poisoner, one of the most deleterious species being *G. uncinatum*.

Gomphosis (Gr. γόμφος). A species of junction of bones where they are let into each other, something like pegs in a board, e. g. as in the teeth of mammalia.

Gomuti. The name applied to an Eastern Palm, and to a bristly kind of fibre obtained from it. The Palm is *Saguerus saccharifer*.

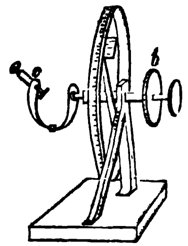
Gondola (Ital.). The name given to the pleasure boats used at Venice, where the numerous canals with which it is intersected generally render it necessary to substitute boats for carriages. The gondola is from twenty-five to thirty feet long, and five feet wide in the centre, where a sort of cabin is constructed for passengers. It is sharp-pointed both at the prow and stern, and is rowed by two men called *gondolieri*. The cabins are furnished with black curtains, which give a sombre appearance at a distance. For an accurate description of the gondola, see Lord Byron's *Beppo*, 19, 20.

Gonfanon or **Gonfalon** (Ital.). In Heraldry, a banner; that of the Roman Catholic church carried in the pope's army. The gonfalonier or standard-bearer was a high officer in the Italian republics of the middle ages.

Gong or **Tam-tam** (of the Chinese). A species of cymbal, which on being struck produces a very loud sound. According to the analysis of Klaproth, Chinese gongs consist of about seventy-eight parts copper and twenty-two of tin. As this alloy is brittle, and the instrument always exhibits marks of the hammer, it is inferred that the Chinese possess the art of rendering it malleable, and afterwards hardening it. It is struck with a wooden mallet covered with leather.

Goniatites (Gr. γωνία, *an angle*). A genus of extinct Cephalopods with chambered spiral shells; nearly allied to the *Ammonites*, but differing in having the lobes of the septa free from lateral crenatures or denticulations, so that the outline of these is continuous and uninterrupted. Goniatites are found in the mountain limestone of Yorkshire.

Goniometer (Gr. γωνία, *angle*, and μέτρον, *measure*). An instrument for measuring angles, and more particularly the angles formed by the faces of crystals. The instrument, chiefly used by mineralogists, was invented by Dr. Wollaston. It consists of a brass circle graduated on the edge, and furnished with a vernier, by which the divisions may be read correct to a minute. The circle moves in a vertical plane, and is supported on a stand. The axis of the circle is a hollow tube, within which is a smaller axis, fitting so tightly that when turned round it carries the other axis and consequently the wheel along with it, unless the latter is purposely prevented from moving. The interior axis is furnished with a milled head *a*, and the exterior with a milled head *b*; so that when the head *a* is held and *b* turned, the circle may be moved independently of the smaller axis; and when *b* is held and *a* turned, the smaller axis may be turned independently of the circle. Attached to the end of the smaller axis is a sort of universal joint, capable of being fixed in different positions by means of screws. The crystal to be examined is attached to the joint at *c* by a little soft wax,



and placed so that its edge shall be parallel to the axis of motion; this adjustment is obtained by placing it so that the image of some horizontal object, as the bar of a window, successively reflected from the two faces of the crystal, shall coincide with another horizontal line seen by direct vision. When this adjustment has been made, the instrument is turned till the horizontal object is seen reflected from one of the faces. The smaller axis is then held fast, and the other turned till the index of the vernier points to the zero of the graduated limb. The circle is then turned round, along with the smaller axis, till the same object is seen in the same position by reflection from the other face of the crystal, when the arc passed through by the circle is obviously the supplement of the angle formed by the two faces of the crystal. In order, however, to avoid the need of calculation, the supplements of the angles are marked on the limb, so that the angle to be measured is read off immediately.

Other forms of the goniometer have been proposed by Charles, Malus, and Brewster. (Biot, *Traité de Physique*, tom. iii.; and Brewster's *Treatise on Philosophical Instruments.*)

Goniometry. The measurement of angles. The term is in many respects preferable to *Trigonometry*, by which it is now replaced; for the latter, strictly speaking, signifies merely the measurement of triangles.

Goniopholis (Gr. γωνία, *angle*, and φολίς, *a scale* on a reptile's skin). A genus of fossil Crocodiles, with subamphicœlian vertebræ, which has been found in the Wealden and Purbeck deposits. The teeth have crowns, which are as round and as thick in proportion to their length as in the existing crocodiles and alligators. The name is derived from the peculiar angular form of the scutes, which are found in a fossilised state in the same strata with the bones.

Gonoplax (Gr. γόνυ, *a knee*, and πλάξ, *a plane*). A genus of crabs or short-tailed crustaceans (*Brachyuri*), characterised by the angular, square, or rhomboidal form of their upper crustaceous plate or carapace, and by the length of the eye-stalks. One species (*Gonoplax rhomboides*) inhabits the Mediterranean, and is a good swimmer; but most of the rest of the genus are tropical.

Gonys (Gr. γόνυ). In Ornithology, the inferior margin of the symphysis of the lower jaw, or the united anterior extremities of the gnathidia.

Good Behaviour, Security for. In Law, a person on sufficient cause shown may be bound with one or more sureties in a recognisance or obligation to the crown before some judicial officer, the recognisance to be void if the person continue of 'good behaviour' for the duration of the recognisance.

Good Conduct Pay. A pecuniary reward to soldiers for good conduct. After three years clear of punishment, a soldier gets an additional penny per diem, and another penny after each succeeding five years clear of the regimental defaulters' book.

Good Friday. The name given in England to the anniversary of our Saviour's crucifixion. The French and most other European nations substitute the epithet *holy* for *good*: the Germans designate this day *Stiller-freitag*, or *Char-freitag*: the latter appellation being derived from an old word *charen*, signifying *to do penance* or *to suffer*.

Good Will. In Law, the *custom*, or benefit of habitual patronage by customers, incidental to an established trade or business. It is usually divided into *local* and *personal* goodwill, though generally it partakes of both elements. It is frequently the subject of sale, and usually survives, on the death of a partner, to the other members of the firm.

Goodeniaceæ (Goodenia, one of the genera). A natural order of perigynous Exogens of the Campanal alliance, distinguished particularly by the induplicate corolla, the indusiate stigma and the two or more celled ovary. Some of them are showy garden plants, but they have no very remarkable properties.

Goodgeons, also called **Braces.** Metal eyes bolted on to the stern post of a ship, for the purpose of receiving the pintles of the rudder. They consequently form the immovable portion of the hinges on which the rudder is held suspended.

Goose. [ANAS.]

Gooseberry. A well-known garden fruit, the produce of *Ribes Grossularia.*

Goosefoot. [CHENOPODIACEÆ.]

Gordian Knot. In History, a knot said to have been made by Gordius, king of Phrygia, in the harness of his chariot, so intricate as to baffle every effort to untie it. The oracle having declared that he who untied this knot should be the conqueror of the world, Alexander the Great, as is well known, made the attempt; but fearing lest in the event of his failure it should be considered as a bad omen, he cut it asunder with his sword; and thus, says Quintus Curtius, either fulfilled the oracle or eluded it. Aristobulus, however, gives a different version of the story. (Arrian, book iii. c. 20; and Plutarch, *in vit. Alex.*)

Gordius (Lat.). The hair worm, or *seta equina*, found in stagnant water in Lapland and elsewhere.

Gorge. In Architecture, the same as CAVETTO [which see].

GORGE (Fr.). In Fortification, the gorge of a work is the line joining its inner extremities. [FORTIFICATION.]

Gorget (Fr. gorge, *a throat*). A piece of body-armour, either scale work or plate, for the protection of the throat; it appears to have been first employed early in the fourteenth century. The *camail*, or throat covering of chain mail, which is sometimes called the *gorget of mail*, belonged more to the helmet than to the body armour. In the seventeenth century the gorget was worn without any other body armour.

Gorget. A surgical instrument used in the operation of lithotomy.

Gorgoneia. In Architecture, carvings of masks imitating the Gorgon, or Medusa's head.

Gorgonia Nobilis (Lat.). *Corallium rubrum*, or red coral.

Gorgons (Gr. Γοργόνες). In Greek Mythology, fearful beings akin in idea to such monsters as Echidna, Chimæra, &c. Homer knows of only one Gorgon, whose head was placed on the ægis of Athena. (*Iliad* v. 741.) Hesiod names three, Stheino, Euryalê, and Medusa. The latter, who alone was mortal, and whose face was so fearful that the sight of it turned the beholder into stone, was killed by Perseus.

Gorilla (derived from the African word *'ngina* or *'nguyla*; Hanno in his *Periplus* termed the females γορύλλαι). The larger species of chimpanzee, which is found in the neighbourhood of the Gaboon, Danger, and Fernan Vaz rivers. This animal has a greater resemblance to man than either of the five smaller species of the same genus, i. e. the chimpanzee (*T. niger*), the kooloocamba (*T. Kooloocamba*), the nschiego 'mbouvé (*T. calvus*), Burton's chimpanzee (*T. vellerosus*), or Aubry's tschego (*T. Aubryi*). The special points in which this resemblance to man is indicated are: the mastoid processes, which are greater than in most monkeys; the conformation of the foot; the form of the nasal bones; and many minute anatomical points. The animal often reaches the height of nearly six feet; and the enormous ridges on the skull to which muscles are attached, give almost a carnivorous character to its physiognomy. The back is greyish; the under or fore part of the body being black; a reddish brown cap covers the head, whilst a whitish stripe extends over the shoulders. The animal was originally discovered by Dr. Savage at Gaboon, and has been copiously described in the writings of Professor Owen, in the *Zoological Transactions*, and also by Messrs. Duvernoy, Isidore Geoffroy St. Hilaire, and Gratiolet.

Gorse (connected by Mr. Wedgwood with Welsh gores, *waste*). [FOREST.] The Common Furze, *Ulex europæus*, sometimes cultivated for the sake of its young shoots, which while soft, or after being crushed by machinery, are given as food to cattle.

Goru Nut. [KOLA NUT.]

Gos-hawk. The *Astur palumbarius* of Cuvier.

Gospel (A.-Sax. Godspell). A word used to signify the whole system of the Christian religion, and more particularly, as the term literally implies, the good news of the coming of the Messiah. The word was also originally applied to the books which contained an account of the life of Christ, many of which were in circulation in the first century of the Christian era, though only four, those of Matthew, Mark, Luke, and John, were admitted into the canon by the council of Nicæa.

Gossip (A.-Sax. God, and sib, *kindred*). This word, now used to denote only a tattler or busybody, was originally applied to sponsors at baptism, from the spiritual relationship in which they stood to the child.

Gossypium (Lat. gossypion). This genus of *Malvaceæ* yields the Cotton-plant, one of the most important of all plants to man. The Cotton-plants are tall shrubs, with lobed leaves, large mallow-like yellow flowers, and somewhat egg-shaped angular pods, the seeds of which are enveloped in a covering of cellular filaments which form the Cotton of commerce. The principal species are *G. barbadense*, *herbaceum*, and *religiosum*; but the Cotton-plant has been so long cultivated and the varieties are so numerous, that their origin cannot be traced with any certainty. One of the most valued sorts is that known as Sea Island Cotton, which appears to have sprung from *G. barbadense*. At the present day, various experiments in hybridising cotton-plants, with the view of improving the staple of the sorts capable of cultivation in particular districts, are being carried on. (*Gardener's Chronicle*, 1864, p. 1085.)

Gothic Architecture. [ARCHITECTURE, GOTHIC.]

Gothic Language. One of the many dialects of the German race, belonging to the Low German class, with a grammar more primitive than the Anglo-Saxon of Beowulf. It is preserved to us in the translation of the Bible made by Bishop Ulfilas in the latter part of the fourth century.

Goulard's Extract of Lead. A subacetate of lead, obtained by boiling powdered litharge in vinegar.

Gourd (Fr. gourde, cougurde). The species of *Cucurbita* are called Gourds, the Common Gourd being *C. Pepo*, of which there are numerous cultivated varieties. Some Gourds are good for food, either alone as a cooked vegetable, or as an ingredient in soups.

Gously. An old form of harp used by the Slavonians, whose bards were called Gouslas, the poetry which they chanted being styled *gouslo*.

Gout (Fr. goutte: if from the Latin gutta, *a drop*, this word points to the old medical theory which attributed all kinds of disorders to the settling of a drop of morbid humour on the part affected, as in the phrase *gutta serena* for loss of sight without visible affection of the eye: Wedgwood, *English Etymology*). Gout is a common disease among the higher classes of society, especially among those who indulge in the luxuries of the table, or inherit a disposition to its attack. Females are much less subject to it than males. Medical writers have distinguished several species of gout, and have called the disease in its ordinary form the *regular gout*. The first symptoms of its attack are those of dyspepsia and irregularity of bowels, low spirits, and some fever and restlessness; but these often pass unobserved, till the patient is roused in the night by violent pain in some part of the leg, generally in the vicinity of the great toe,

and of one foot only: there is much throbbing and uneasiness, with more or less swelling and inflammation, and the least motion commonly produces great increase of suffering. After some hours the pain and fever abate, perspiration comes on; the patient falls asleep, and awakes comparatively easy. These fits or paroxysms are apt to return at intervals, and often every evening; but they decrease in violence, and at length go off, frequently with some decided increase of perspiration or other evacuation: the affected part itches, and the cuticle peels off, more or less lameness or uneasiness remaining. But the fit thus leaves the patient only for a time, and returns at intervals of longer or shorter duration, according to his habit of body and the care which he takes of himself. The attacks not only become more frequent and severe, but last longer, and extend to other limbs; and when they have been frequently repeated, they leave a permanent stiffness of the joints, upon which *gouty concretions* are often deposited: and if much attention is not paid to the state of the urine, fits of sand and gravel not uncommonly precede or accompany those of gout. Where the disease is of long standing, and the form of it severe, the body becomes maimed and decrepit, and the mind often worn and irritable; the joints of the feet and hands, and even the larger joints of the extremities, are stiff and nearly immovable; and the formation of the chalky matter, as it is called, about the joints increases. If we consider the nature of this secretion in the joints, which is *urate of soda*, and the tendency of gouty persons to those morbid states of the kidneys and urine which depend upon excess of uric acid, and even upon the frequent alternation of fits of gravel with those of gout, the question will naturally suggest itself whether gout is not a symptom of what is often termed the *uric diathesis*, and whether the remedies applicable to it may not be beneficial in gout; and that in many cases they are so, seems to have been amply proved by experience. [CALCULI.] It was once a favourite maxim that the gout was an effort of the system to relieve itself of some peccant matter; that, therefore, it was to be left almost to itself, and that patience and flannel were the chief remedies. This method still has its advocates, chiefly in consequence of the presumed dangerous results that have sometimes attended more active plans of treatment in causing the revulsion of the gout from the limb to the stomach or head. But though there may be a difference of opinion in regard to certain energetic modes of relieving the disease, no one can object to the adoption of gentle means of quieting the urgency of the symptoms, and to the adoption of such diet and plan of living as appears to diminish the frequency of their recurrence. Warm laxatives, moderate diaphoretics and diuretics, and occasionally opiates, are among the former; and plain food or vegetable diet, with moderate exercise and tonics, are good preventives. Those, however, who have witnessed the sufferings of a regular paroxysm, and the evils of its duration and repetition, will see the necessity of doing something more; that is, of speedily quelling the pain and carrying off the attack, if it can be done with any chance of safety and success; and this experience shows to be often the case, though much care and judgment are undoubtedly requisite in conducting such treatment. With persons of strong and healthy habits, the affusion of cold water is one of the most effective palliatives of the pain and inflammation; and by its timely application, *in proper cases*, the most beneficial results have ensued. Another celebrated remedy in this disease, and which by some has improperly been called a *specific*, is *colchicum*, or *meadow saffron*, a due dose of which, taken at bedtime, has carried off the paroxysm. This it often does without any remarkable evacuation, though it sometimes handles the patient severely as a purgative, and nauseates and depresses to an alarming extent. This method of cure must not be unadvisedly and generally adopted; but in some cases, where gout had been long established, and where the frequency and duration of the fits and their inroads upon the constitution were increasing to a serious extent, and that at an advanced period of life, colchicum, carefully administered, seems to have carried off the severity, if not the frequency, of the attacks, and so to have prolonged life. But there are forms of gout, and consequences of gout, the management of which requires the utmost skill and experience: it is sometimes transferred or translated from the limbs to some internal part, in which case it is called *retrocedent gout*; or it produces sickness, dejection of spirits, fainting, palpitation, and giddiness, as in what is termed *atonic gout*; or it falls at once upon some internal part, especially the stomach, and is then called *misplaced gout*. In gout of the head and of the stomach the symptoms are often frightfully severe, and the pain excessive; and as these forms of gout are of most common occurrence in debilitated habits and broken constitutions, they become, on that account, the more difficult to treat: the expulsion of the disease to the extremities is in such cases sometimes effected by ether, brandy, or what are termed *gout cordials*, which generally consist of warm aperient tinctures; but before these are administered, it must be ascertained that the symptoms are really those of atony. In such cases, putting the feet in warm water has sometimes been serviceable. The moderate use of alkaline remedies, of a vegetable diet, of certain diuretics, and generally speaking the adoption of those plans of regimen and medicine which are useful in the uric diathesis, are also useful in gout; and everything which tends to repair the constitution generally will lessen the liability to its attacks, and render them more manageable when they occur. The indolent and sedentary must use moderate exercise, and those who habitually over-exert either body or mind must endeavour to tranquillise both: unless such

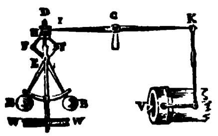
precautionary measures are peremptorily enforced, no gouty person can expect much benefit from physic.

Gouty Concretions. These form in the joints of gouty persons, especially of the toes and fingers, and are sometimes, from their appearance, called *chalk stones*; they are chiefly composed of uric acid and soda.

Government (from Lat. guberno, properly *I steer a ship*, like the Gr. κυβερνάω). In Politics, a word used in different senses: 1. As the collective body of the fundamental laws of a state: as when the government of a country is said to be monarchical, aristocratical, &c. 2. The body of persons charged with the conduct of the executive in any country: thus, the king or presiding magistrate, the cabinet ministers, chiefs of departments, &c. in every country, form what is commonly styled its government. [LIBERTY.]

Governor. The title of the supreme executive officer in British colonies. He is in all cases appointed by the crown, and has the right of *veto*, i.e. of negativing any proposed legislative measure; while his own sanction of any such measure is subject to reversal by the crown at home. In other respects, his functions vary greatly according to the various constitutions of the colonies. The heads of the presidencies of Madras and Bombay in India are also styled *governors*. In the North American Union, the title has been retained, as a relic of the old colonial times, for the chief officer of the executive in each state, who is elected for a term by the people.

Governor of an Engine. A contrivance introduced by James Watt in the steam engine,



by which the motion of the fly-wheel shaft regulates the velocity of the engine, by causing two balls to revolve in such a manner that they open, or close, the passage of the steam from the boiler, by means of a butterfly valve, in proportion to the increase of velocity. Two heavy balls, B B, attached to the extremities of two rods B F, B F, play upon a joint at E, passing through a mortise in the vertical shaft D D. These are united by joints at F to the short rods F H, which again are connected by joints at H to a ring which slides on the shaft D D. A horizontal wheel, W, is attached to D D, having a groove to receive a rope or strap on its rim, by means of which the motion is communicated to D D from a corresponding wheel on some shaft of the machinery to be regulated. It is evident, from the disposition of the rods, that if the balls B B are by any means raised or drawn asunder, the extremities F F of the rods turning on the pivot E will also be separated, and their distance from the axis increased. This will draw the rods F H in the same direction, and cause the ring or collar H to descend. This ring is connected with the end I of a lever, whose fulcrum is at G, and whose other extremity K is connected by some means with the part of the machine which supplies the power. Suppose now the velocity from any cause to undergo a sudden increase; by reason of the increased centrifugal force arising from the whirling motion, the balls B B will recede from the shaft D D, and raise the extremity K of the lever. On the other hand, if the velocity is diminished, the centrifugal force of the balls will be diminished, they will fall by their own weight nearer the axis, and cause the end K of the lever to descend. When the governor is applied to a steam engine, the rod K I communicates with a flat circular valve V, placed in the principal steam pipe, and so arranged that when K is elevated as far as the divergence of the balls will allow, the opening of the pipe will be closed by the valve V, and the passage of steam entirely stopped. On the other hand, when the balls subside to their lowest position, the valve will be entirely open. Thus, when the velocity is increased, the supply of steam is checked; and when it is diminished, the supply of steam is immediately increased; by which means a uniform proper velocity of the machinery is maintained. [REGULATOR.]

Governor-General of India. The chief executive officer of that dependency: appointed by the crown, and usually serving for a term of five years. His powers are very high, extending to the declaration of war and peace, and making leagues and alliances; but subject in all matters to the control of the crown, through the Secretary of State for India. Almost all acts of state are performed by the governor-general 'in council;' that is, with the advice of his council, although not necessarily in accordance with the majority. This council consists of five ordinary members, three of whom must have been 'civil servants,' and the commander-in-chief as an extraordinary member. When the council meets for purposes of legislation, certain 'additional' members are summoned under the provisions of the Indian Council Act of 1861. But the governor-general is authorised by the same Act, in case of emergency, to make regulations of his own independent authority, having force of law.

Grabs. Small armed vessels used on the coast of Malabar.

Grace (Lat. gratia). In the language of the New Testament, is primarily the favour and love of God towards any person: thence it comes to be used in various derivative senses, being put generally for all the extraordinary means and assistances with which men are endowed to bring them to salvation. The term is used, further, for the good actions and dispositions of men, which may be supposed to be derived from the operation of the grace of God in the first instance. [PELAGIANISM.]

GRACE. In the Fine Arts, a quality arising from elegance of form and attitude combined. A figure may be just in its proportions, its parts and members may be all perfectly regu-

lated, yet it may be deficient in grace. It is scarcely possible in words to express this quality, yet it is constantly seen in nature; and it is scarcely possible to contemplate a picture by Raphael without feeling its power.

Grace, Days of. In Commercial Law, certain days allowed by the custom of merchants to be added to the time requisite for presentment of a bill. Thus, if an instrument drawn in this country be payable 'a certain time after date,' three days of grace are added: a bill drawn on August 27, payable 'two months after date,' is therefore due on October 30. So if a foreign bill be drawn at one, two, or more *usances*, the days of grace are added to the usance. The usance between London and Paris is one calendar month: a bill drawn in London on Paris, 'at one usance,' on Jan. 2, is consequently due on February 5. The number of days of grace varies in different countries. In France none are allowed.

Grace at Meals, The Saying of. A Jewish custom sanctioned by the practice of our Lord, and adopted by the early Christians. A custom of beginning meals by invocations was common in classical antiquity. (Livy xxxix. 43; Quintil. *Declam.* 301.)

Graces (Lat. Gratiæ). In Latin Mythology, the Graces answer to the Greek CHARITES [which see].

GRACES. In Music, ornamental notes attached to principal ones, such as the APPOGGIATURA, SHAKE, &c. [which see].

Gracioso (Ital.). The buffoon; a favourite character on the Spanish stage.

Gracula (Lat. graculus, *a daw*). A genus of Dentirostral Passerine birds, characterised by a moderately long, slightly arched, and notched beak; nostrils situated anterior to the base of the beak, oblong, open, and notched; tongue with a short apex, often bifid. One species of this genus (*Gracula tristis*, Cuv.) is a native of India, and has been imported into the islands of Bourbon and Mauritius, where it is held in the highest estimation for the services it performs in checking the increase of locusts. The bird commonly called the mino grackle (*Gracula religiosa* of Linnæus) is the type of the genus *Eulabes* of Cuvier.

Gradatory (Lat. gradus). A term applied in Mammalogy to the extremities of a quadruped which are equal, or nearly so, and adapted for ordinary progression on dry land. In Ornithology, the *pedes gradarii* are those in which the whole tibia is covered with feathers.

Grade (Lat. gradus, *a step*). According to the French method of estimating angles, a grade is the hundredth part of a right angle: each grade is further divided into 100 minutes, and each minute into 100 seconds, so that ·053730 of a right angle denotes 5 grades 37 minutes and 30 seconds, or as it is sometimes written $5^g\,37'\,30''$. Whence may be deduced an easy method of converting grades into ordinary degrees.

Gradient (Lat. gradior, *I step* or *go*). The inclination given to a road, canal, or river. The rate of inclination is expressed in England by taking the foot as the unity, and saying that the gradient is one in so many feet as there may be; in the continental style, the unity is always the mètre, and the gradient is quoted in subdivisions thereof. Thus in English documents it is said that the gradient would be 1 in 100 feet when the rise, or inclination, is 1 in height to 100 feet base; in continental phrase it would be called a gradient of 0·01m. to 1·00m. Formerly it was thought necessary to employ much easier gradients for the locomotive than some which are now admitted, an inclination of 1 in 200 being then considered to be the maximum inclination that should be allowed, whereas 1 in 33 is considered quite within the limits of practice. The maximum inclination of mail coach roads is taken as 1 in 30; that of country roads as 1 in 20; that of occupation roads as 1 in 8 occasionally: the gradients of river navigation are usually considered to be from 1 in 2,000 to 1 in 1,250, at which rate the navigation of the Rhône was for a long time maintained with considerable profit.

Graduale (Lat. gradus). An anthem sung in the Mass of the Roman Catholic church after the epistle. [AMBO.]

Graduate (Lat. gradus). One who has taken a degree in a college or university. [DEGREE; COLLEGE; UNIVERSITY.]

Graduated. In Ornithology, when the quill-feathers of the tail increase in length by regular gradations.

Graduation. In Practical Astronomy, the division of circular arcs into degrees, minutes, &c. This is an art which, though depending on the geometrical properties of the circle, requires for its successful execution the application of very great practical skill. For the principles, see Mascheroni, *Géométrie du Compas*; and for the practical part, Troughton's 'Account of a Method of Dividing Astronomical and other Instruments. &c.,' in the *Phil. Trans.* 1809, as also his article 'Graduation' in Brewster's *Encyclopædia*.

Graduator. A contrivance for accelerating spontaneous evaporation by the exposure of large surfaces of liquids to a current of air has been termed a *graduator*; and in some salt works, where the brine is strengthened by allowing a shower of it to trickle over faggots, the process is called *graduation*. Vinegar is sometimes manufactured in a kind of graduator, by suffering a mixture of alcohol and water, previously mixed with some ferment, to trickle through a tub filled with beech shavings, through which a current of air is at the same time passing.

Grafting (Fr. greffe). In Horticulture, the operation of affixing a portion of one plant to another in such a manner as that a vital union may take place between them. Grafting may be performed both with herbaceous and ligneous plants; but in practice it is chiefly confined to the latter, and more especially to the propagation of esteemed varieties of fruit-trees. A

grafted plant consists of two parts: the stock or stem, which is a rooted plant fixed in the ground; and the scion, sometimes, but erroneously, termed the *graft*, which is a detached portion of another plant to be affixed to it. The operation of grafting can only be performed within certain physiological limits; but these limits have not yet been absolutely determined.

In general, all the species of one genus may be grafted on one another reciprocally; but this is not universally the case, because the apple cannot be grafted on the pear, at least not for any useful purpose. In general, it may be presumed that all the species of a natural order, or at least of a tribe, may be grafted on one another; but this does not hold good universally. The reverse of this doctrine, however, viz. that the species belonging to different natural orders cannot be grafted on one another, holds almost universally true; and therefore a safe practical conclusion is, that in choosing a stock, the nearer in affinity the species to which that stock belongs is to the scion, the more certain will be the success.

Grafting is one of the most important operations in horticulture, as affording the most eligible means of multiplying and perpetuating all our best varieties of fruit-trees, and many kinds of trees and shrubs not so conveniently propagated by other means. Varieties of fruits are originally procured by selection from plants raised from seed, but they can only be perpetuated by some mode which continues the individual; and though this may be done by cuttings and layers, yet by far the most eligible mode is by grafting, as it produces stronger plants in a shorter time than any other methods.

Grafting is performed in a great many different ways; but the most eligible for ordinary purposes is what is commonly called *splice grafting*, or *whip grafting*. In executing this mode both the scion and the stock are pared down in a slanting direction, and afterwards applied together, and made fast with strands of bast matting, in the same manner as two pieces of rod are spliced together to form a whip handle. To insure success, it is essentially necessary that the alburnum or inner bark of the scion should coincide accurately with the inner bark of the stock; because the vital union is effected by the sap of the stock rising up through the soft wood of the scion. After the scion is tied to the stock, the graft is said to be made; and it only remains to cover the part tied with a mass of tempered clay, or any convenient composition that will exclude the air. The season for performing the operation is, for all deciduous trees and shrubs, the spring, immediately before the movement of the sap. The spring is also the most favourable season for evergreens; but the sap in this class of plants being more in motion during winter than that of deciduous plants, grafting, if thought necessary, might be performed at that season.

Grafting by approach, or inarching, is a mode of grafting in which, to make sure of success, the scion is not separated from the parent plant till it has become united with the stock. For this purpose the stock and the plant containing the scion must be growing close together; and the scion being drawn to one side, and made to approach the stock, is spliced to it by cutting off a portion of its bark and wood, and a similar portion of the bark and wood of the stock, applying the one to the other so that their alburnums may join, and then making both fast by matting, and excluding the air by clay, grafting wax, or moss. When the scion has effected a vital union with the stock, its lower extremity is cut through, so as to separate it from the parent plant, and it now becomes an independent graft. In this way trees of difficult propagation may be propagated with certainty; while if any of the other modes of propagation, whether by cuttings or grafting, were adopted, a proportion of the cuttings or scions would, in all probability, be lost.

Grafting herbaceous plants differs in nothing from grafting such as are of a woody nature, excepting that the operation is performed when both stock and scion are in a state of vigorous growth. It is less practised than the grafting of woody plants.

Grafting the herbaceous shoots of woody plants—the *greffe herbace* of the French—has been extensively employed in France. The scions are formed of the points of growing shoots; and the stocks are also the points of growing shoots cut or broken over an inch or two below the point, where the shoot is as brittle as asparagus. The operation is performed in the cleft manner; that is, by cutting the lower end of the scion in the form of a wedge, and inserting it in a cleft or slit made down the middle of the stock. The finer kinds of azaleas, pines, and firs are propagated in this way in the French nurseries; and thousands of *Pinus Laricio* have been so grafted on *Pinus sylvestris* in the forest of Fontainebleau. At Hopetoun House, near Edinburgh, this mode of grafting has been successfully practised with *Abies Smithiana*, the stock being the common spruce fir.

Grain (Lat. granum). By a statute passed in the reign of Edward III. (1266), it was enacted that thirty-two grains of wheat, taken from the middle of the ear and well dried, should constitute a pennyweight, of which there were to be twenty in an ounce. The grain now in use, however, is the 7,000th part of a pound (avoirdupois); in other words, the 70,000th part of the weight of an imperial gallon of water at 62° Fahr., the barometer being at thirty inches. Under the same conditions, a cubic inch of water weighs 252·458 grains. The grain is the unit of our system of weights. [WEIGHTS.] The French decigramme is about 1·5 English grains, the gramme being = 15·434 English grains.

Grain Tin. The purest kind of tin. The term was formerly applied to the metal obtained from the rounded pebbles of tin stone, called *stream tin*. The peculiar columnar fracture which pure tin exhibits when broken,

is given by heating the ingot till it becomes brittle, and then letting it fall from a height upon a hard pavement.

Grains of Paradise. The seeds of a species of *Amomum*: they are acrid, and said to be the *malagueta pepper* of Africa. They are also called *guinea grains*, and are largely imported from Africa. They are used to give a pungent flavour to spirits, beer, and vinegar. By 56 Geo. III. c. 58 no brewer or dealer in beer shall have in his possession or use grains of paradise, under a penalty of 500*l.* for each offence. An erroneous notion prevails that these seeds are injurious; in Africa they are esteemed a wholesome spice, and used by the natives to season their food.

Grallæ (Lat. *stilts*). The Linnæan name of the order of long-legged wading birds.

Graminaceæ (Lat. gramen, *grass*). An order of Endogenous plants, commonly called *grasses*, in which the parts of fructification are essentially perfect, although they are in a very unusual state in what may be called their accessory organs. They have neither calyx nor corolla; but, in lieu of them, imbricated scales, called *paleæ* and *glumes*: the latter of which give rise to the name *glumaceous*, often applied to these plants. They are nearly allied to sedges, from which they differ in having the sheaths of their leaves slit and their stems hollow.

The Grasses are widely distributed over the world, including about one in twenty two of all known plants, according to Schouw. They are social plants, forming herbage in temperate climates, and becoming arborescent in the tropics. The order is a most important one, but not uniformly wholesome, for Darnel grass, *Lolium temulentum*, is said to possess poisonous qualities, which are attributed also to the *Festuca quadridentata* of Quito, to *Bromus purgans*, *catharticus*, and *mollis*, and to an Indian variety of *Paspalum scrobiculatum*. Several species of Andropogon yield fragrant oils. [Grass Oil.] The bamboo, *Bambusa arundinacea*, is one of the most useful grasses in warm countries; as also is the sugar cane, *Saccharum officinarum*, in a commercial point of view. The principal cereal grasses cultivated for food are, Wheat, Barley, Oats, Rye, Rice, Indian Corn, Millets, Guinea Corn, and Swamp Rice. The grains of *Coix lachryma* are used as beads under the name of *Job's tears*. Some kinds of grass, as the *Ammophila arenaria* and *Elymus arenarius*, are useful in binding the loose sand of the seashore. Ergot is the ovary of rye attacked by a fungus called *Oidium abortifaciens*. The flinty surface of the stems or straw renders many valuable for domestic use, as for forming the *plat* from which straw bonnets, &c. are manufactured. The systematical arrangement of grasses is a difficult and unsatisfactory task, and has occupied the attention of many botanists. Sinclair's *Hortus Gramineus Woburnensis* will, however, be found a useful account of the relative qualities of pasture grasses.

Grammar (Gr. γραμματική, sc. τέχνη, *the grammatical art*; from γράφω, *I write*). The science which has for its object the laws which regulate human language. Language, in its widest acceptation, may be defined to be the expression, by means of outward signs, of what passes in the mind. If, therefore, it is to admit of rules, or general laws, it is plain that we must seek those laws either in the constitution of the mind where it originates, or of the outward materials of which it is composed. These are either sounds, visible images (i.e. letters as representing sounds), or gestures. Grammar takes account of the first two only. [Gesture Language.] The material of language, when it is *sound*, is capable of analysis into a definite number of simple elements. It is not our object at present to enter on the consideration of this part of language, whether consisting of sound, or marks to designate sound. We pass on to its more important class of laws, which result from the internal conditions of the mind; and which, viewed in that reference, constitute the subject-matter of philosophical grammar, properly so called. An analysis of our mental faculties must therefore precede any attempt to define the province and settle the principles of grammar. Of the various divisions of the human faculties proposed by philosophers, we shall adopt, as best suited to our purposes, that which distinguishes them into two grand classes — the province of affection, and that of perception or intellection. The discriminating mark of the former class, under which we include alike the outward senses and the inner sense or emotion, is this, that the faculties which it includes imply a state of mind or consciousness, and that only. By perception or intellection, on the other hand, are meant those states of mind which refer to a real or supposed *object*, out of the mind itself. 'To know' and 'to know nothing' are contradictory conceptions; every act of knowledge implies at once an object and a mind to which that object is present. Each of these portions of the mind has its appropriate expression, its peculiar language. The language of emotion is common to men and animals. It consists, for the most part, of certain simple sounds or exclamations, which, if capable of being reduced to rules at all, must rest for those rules on physiological considerations, which form the province of philosophical grammar. We must seek that province, consequently, in the language of intelligence or reason. Rational discourse, or human language, may be figuratively expressed as the outward *type* or *form* which thoughts, and the laws which regulate them, impress on the *material* of sound. In the words of Plato, 'reason and discourse are one; only the former, as the conversation of the soul with herself, which goes on without the intervention of sound, has obtained among us the name of discourse of reason.' We do not deny that language, in this limited sense, may become the expression of emotion in ourselves, and excite emotion in others. Both these objects,

however, it can effect only *mediately*: the first, by converting, through reflection, an emotion into an object of consciousness; by rendering it *intelligible* to ourselves, then *intelligible* to others: the second, only *through* the understanding of those whom we address. The laws of language must therefore correspond with the laws of the intellect: if there is anything universal and necessary in the one, its representative or image must be found repeated in the other. But the necessary laws of thought are the object-matter of logic. It might, therefore, seem that logic and universal grammar are convertible terms. Both sciences consider alike the forms of the intellect, and the right mode of expressing these forms in language. But they differ in this, that logic considers the intellectual process primarily, and its expression in language only incidentally; whereas grammar considers the former only in so far as it conduces to the right understanding and due regulation of the latter. Having previously distinguished philosophical from merely practical or empirical grammar, we may now distinguish philosophical grammar itself into universal and particular. The first, as we have seen, corresponds to logic: as the one is the science of those conditions which must be presupposed in order to render *thought* and *intelligence* possible; so the other contemplates the conditions which are to render possible the *outward expression* of thought and intelligence. The same relation which universal grammar bears to logic, particular grammar, philosophically treated, may be said to hold to the kindred science of psychology. It considers the experimental laws of the mind with the same view with which universal grammar contemplates those that are necessary. It takes into account the effects of accidental association, in order to explain the idioms or peculiarities of the particular language before it. It calculates, so to speak, the disturbing forces which act on the general law.

In developing the principles of universal grammar, we shall consider, in order, the various kinds of words or *parts of speech* into which language is ordinarily distinguished.

The first class of words corresponds to the faculty called by logicians *apprehension*, or simple apprehension. They are commonly named *nouns*, or *substantives*, or *nouns substantive*; and express either individuals, as 'John, Charles;' or classes, as 'man, animal.' They are called *substantives* because they express a real or supposed substance, a something which is conceived to stand under, or, in scholastic language, to be the support of certain qualities. These qualities may in their turn be considered as substances, and expressed by substantives, as *whiteness, greenness*. When considered in relation to the substance of which they are properties, they constitute the second class of words—*adjectives*, or *nouns adjective*. Thus we say, '*a white* horse, a dazzling *whiteness*,' where the same conception which in the former case is regarded as a quality, and expressed by an adjective, is in the second converted into a substance, itself the *support* of other properties.

Thus far the only intellectual power implied in language is that of forming general conceptions. A conception, when formed, is capable of being resolved back into its constituent parts. In the conception 'stag' we find the property of swiftness contained. This *attribution* of a quality to a substance, is what logicians call a *judgment*; its expression in language is an affirmation, or proposition. The *sign* of this attribution is called the *copula*: 'The stag *is* swift.' Every judgment which has regard to matter of fact considers an event either as past, present, or future: 'The hair *was* light, *is* dark, *will be* grey.' When the attribute property or quality is combined with the copula or word signifying the affirmation or attribution, a third class of words is produced, to which we give the name of *verbs*. Thus instead of saying, 'the sun *is* bright,' we may say, 'the sun shines,' where the latter form of expression is equivalent to, or capable of being analysed into, the former. A *verb* is therefore a compound part of speech, consisting of an adjective and a *copula* or *affirmation*, and signifying not only the conception of a *property*, but our perception or judgment that such property does inhere or belong to some substance, or else that it *has* belonged or *will* belong to it. The relation between property and substance, expressed in every proposition, may be differently stated as the relation of part to whole, of species to genus, of individual to species; distinctions which do not concern us at present, inasmuch as grammar, no less than logic, has regard only to our mode of conceiving things, not to things as they are in themselves.

The three parts of speech which we have thus analysed—the substantive, the adjective, and the verb—are called the *primary* or *essential* parts of speech. They are those without which no discourse could take place, no act of judgment be communicated; in other words, without which no sounds could have *meaning*. The parts of speech which remain to be considered are the *pronoun*, the *article*, the *adverb*, the *preposition*, the *conjunction*, the *interjection*.

The *pronoun* is so called from its being a substitute for a noun; a compendious contrivance to avoid repetition, or needless and inconvenient specification: as, 'John is tall and *he* is handsome,' which is equivalent to saying, 'John is tall and *John* is handsome.' They are commonly subdivided into personal or substantive, adjective, demonstrative, relative, indefinite, and interrogative pronouns.

Articles are words joined to substantives, for the purpose of defining whether the substance or conception is to be understood in a general sense, or in particular relation to an individual. When the first is our intention, we use in English no article whatever: as, '*Man* is corrupt;' by which we mean that corruption is an attribute of the genus 'man,' and not of any particular individual to the exclusion of others. If we used the article *a* or *an*, we should in

most instances mean that some individual or other of the species was contemplated: 'I saw *a* horse.' When we use the definite article *the*, we mean to specify which individual of the species we have in view.

The *adverb* derives its existence from the difficulty of defining by one word the precise quality of a particular object. When we say a thing is 'green,' we may call up in the minds of our hearers the image of a very different shade of greenness from that which we are describing. If we say it is '*very* green,' our language is more definite. An adverb may consequently be described as a *modifying* part of speech, joined with adjectives or verbs to define more accurately the degree of the quality or circumstances of the action predicated. That it is not an essential part of language is evident from the circumstance that its place may be supplied either by a termination, as 'green*ish*,' for 'rather green;' or by a periphrasis, as 'he walks with speed,' instead of 'he walks rapidly.'

Prepositions are those parts of speech which express relations between substances, and are consequently joined only with substantives; as, '*from* the city *to* the country.' We shall consider them more at length when we come to treat of the inflections of words.

As prepositions express objective relations, so *conjunctions* may be said to represent those of a subjective nature; or those relations which we perceive to exist between the judgments of our own intellect, whether of mere succession, of inference, or the like. They are consequently used to connect propositions together; as, 'John is wise, *therefore* he is good;' 'John is wise *because* he is good,' &c. They are to the syllogistic faculty, or the faculty which perceives the connection and dependence of simple judgments, what the *copula* is to the faculty which forms these judgments. As the one forms words into propositions, so the other are necessary to combine propositions into sentences.

The *interjection* is the expression of emotions, and emotions only. It is not, therefore, confined to *human* discourse; and as it has nothing to do with the operations of the intellect, is incapable of logical combination with other words. It might therefore be doubted whether it can with propriety be called a part of speech at all.

We have said that the last-mentioned 'parts of speech' were not *necessary* constituents of language. We so far qualify that assertion, in regard to prepositions in particular, as to admit that they are the expressions and modes of conception which the human understanding unavoidably forms. Whether, in technical language, the necessity be a *formal* or a *material* necessity, we forbear to discuss at large; since it is a subject on which logicians are not agreed. We ourselves are inclined, with Kant, to think it *formal*. We conceive the relations of cause and effect, of time and place, of action and passion, to be as much pure educt of the understanding, and as independent for their *form* on experience, as those of *part* and *whole*, *substance* and *attribute*, which we have seen to constitute the necessity for the primary parts of speech. They differ, however, in this, that the latter *must* enter into every proposition to render it a proposition at all; while those which we are now considering may or may not, according to the matter in hand. In all languages they are expressed more or less perfectly. In our own, and in the other branches of the Teutonic stock, this expression is effected in two ways. Either the relation intended to be implied is expressed by an affix or prefix to the radical or abstract portion of the word itself; or the relation is regarded as abstracted from all particular objects between which it might be conceived to subsist, and, so abstracted, is embodied in a distinct word or particle. Thus what the Latins expressed by the termination *o* or *i*, as '*domino*,' '*nubi*,' is represented in English by the prepositions 'to' or 'for.' Generally speaking, the earlier a language, the richer it is found to be in terminations; which, as the faculty of abstraction becomes habitual, are commonly abridged in number, and replaced by particles. A word which admits a variety of such modifications is said to be *declinable*. The only *declinable* or *inflected* parts of speech are the substantive and the verb, and in some languages the adjective and participle, with the representative parts of speech, the pronoun and article. The reason of this is sufficiently obvious. It is between supposed *substances* that the relations of cause and effect and those of place are conceived to exist; while the relations of *time* pertain to action and passion, or those changes in the state of substances which are expressed in language by verbs. The declension of adjectives is an anomaly in language. It probably results from the facility with which we convert in our thoughts a quality or attribute into a substance: unless it is to be accounted for by what grammarians call 'attraction;' a supposed influence which the inflexion of a word exerts over those immediately in contact with it, and which is owing partly perhaps to the desire of euphony, and partly to a confusion of thought, the effect of association. The sum total of the modifications which the words of a language admit constitute what is called the *accidence* of that language. The circumstances under which such modifications or inflexions take place are the subject-matter of that part of grammar which is named *syntax*. These inflexions are, in *nouns*, case, number, and gender; in *verbs*, tense, mood, person, and, in most languages, number.

The *cases* of nouns are the expression of the relations of substances. In Latin there are, besides the nominative, or absolute form of a conception, and the vocative, used in addressing or calling to another person (a compound of a noun and an interjection), four cases properly so called; the genitive, the dative, the accusative, and the ablative. Of these the English language retains in its nouns one only, the genitive; in its pronouns two, the genitive and

accusative. All other cases it replaces by prepositions.

The genitive case expresses the relation of *property*. A single conception is capable of being analysed into a number of constituent parts, which are either necessary to the whole conception, or bound up with it by association more or less habitual. We represent this process in language by some change either in the word which signifies the *property*, or in that which denotes the containing substance. The last is the case in most European languages. Thus, we speak in Latin of color equi, *the colour of a horse*; philosophia Socratis, *the* [illegible]*y of Socrates*. For the controversy respecting the genitive case in English, see the *Inquiry into the Character and Origin of the Possessive Augment*, by Serjeant Manning.

The dative case implies *participation* in the effect of an action, expressed in English by the preposition 'to' or 'for.' 'Dedi ei,' 'I gave it *to him*;' where the effect of my act of giving is *shared only* by another.

The accusative is used where the effect of an action is conceived as passing over *entire* to another substance: 'Laceravi librum,' '*I tore the book*;' where the whole of the immediate effect is conceived as confined to the book which I tear. It is also called the *objective case*.

The ablative case, if we regard its etymology only, we should define to be that which expresses loss or privation. In this sense it ought to be considered as a modification of the dative, or the case which expresses the incidental or participated effects of an action; and we accordingly find that in Latin the English preposition 'from' is frequently expressed by the dative. There is, however, a kind of relation which no other case serves precisely to convey, that of outward proximity, which is expressed in English by such prepositions as *at*, *near*, *by*, *upon*, and in Latin by the ablative case, which consequently is not so useless or superfluous a form as some grammarians have considered it to be. It must, however, be remembered that this system of cases is in some measure the arbitrary work of Greek and Latin grammarians, and that great confusion and difficulty has been caused by treating as a single case what are really several cases, although alike in form. [LOCATIVE CASE.]

Besides the inflexion of case, nouns admit, in most languages, those of number and gender. The latter is a mere generalisation from experience; and though it may be convenient to have a termination to designate it, it is not necessary, as is apparent from our own language, which expresses this distinction only in its pronouns, and in some few of its substantives. Our conceptions of number are doubtless conditions of our mental constitution. They may be generalised under the forms of unity simple, unity comprehensive, and plurality. Unity, whether regarded simply or as an aggregate, is expressed by the singular number. Many languages, besides singular and plural, have a form to denote duality, or *two things together*; a fact which, probably, is owing to the duality of the parts of the human body, as the hands, feet, &c.

We proceed to consider the different kinds of *verbs*, and their modifications. Verbs are divided into transitive, intransitive, and passive. They admit necessarily of time and mood; accidentally and by usage, of *person* and *number*.

A property, taking the word in the most general sense of which it is capable, may be conceived either as a state, a process, or as a power in action. To the first two correspond the verbs commonly called intransitive, or neuter, as 'I rest,' 'I grow,' 'I fall.' When a power is in action, we measure it by its effects on some substance; we conceive the action as *passing on* to another object, as 'the clouds bring rain.' The verb which expresses this transition is called the *verb active* or *transitive*. But not only are we able to conceive an object exerting power; we may also consider it as susceptible of influence or change from the action of another object. This is expressed by the verb passive, as 'the dog *was beaten*.' Many other modifications of action and change have their appropriate forms in different languages. Such are the verb middle or reflex in Greek, the verbs frequentative and desiderative in Greek and Latin. These, however, are matters of idiom, not of universal necessity.

Equally extensive with the conceptions of cause and effect is that of time, as the universal condition of all change in nature. The words which signify the one must therefore be capable of expressing the other. Hence the necessity for *tenses* in verbs, or the inflexions which determine the time of the action, as present, past, or future. We may further abstract an action from its relation to time altogether; and this abstraction is in some languages, as in the Greek, represented by a form appropriate to the purpose, called the *aorist*. [AORIST.]

The modifications of verbs which we have been considering concern change or action objectively, or in relation to the substances which they are supposed to affect. Our judgments themselves are also liable to certain modifications, which, as regarding only the way in which we conceive of events, may be said to constitute the subjunctive conditions of verbs. Our knowledge of an occurrence may be either certain or uncertain; and uncertain either absolutely, or only under particular suppositions. When we simply express our judgment that a thing is, has been, or will be, in such and such a state, we are said to speak indicatively, or in the *indicative mood*. When we consider a thing as possible merely, we use the *potential mood*, denoted in English by the auxiliary verbs 'may' or 'might.' When we speak of it as dependent for its occurrence on certain conditions, or in case of its occurrence as connected with certain probable or inevitable consequences, we use the *conjunctive mood*: 'I *would* go, if he *would* let me.' Different languages express these modifications of judgment more

or less perfectly; none, perhaps, with absolute accuracy.

Two other modal forms still remain to be considered. They have been called by grammarians the *imperative* and *optative moods*, as conveying the expression of a command or a wish. They may be included under the general term of *desiderative*, and imply at once the conception of an event and our desire that that event should take place. They may therefore be regarded as forming the connecting link between verbs and interjections; between the words which belong to the perceptive and those which pertain to the emotive part of our nature.

What is commonly named the *infinitive mood* may be considered as the point of transition from a verb to a substantive. It is, so to speak, a *substantised attribute*, and is used as the subject of a proposition as correctly as substantives themselves: e.g. '*To die* is gain.'

The *participle* is usually ranked as a separate part of speech. It may be said to hold the same intermediate place between a verb and an adjective, as the infinitive holds between a verb and a substantive. It possesses all the properties of the verb, save affirmation; that is to say, to the properties of the adjective it adds the power of denoting time.

The attribution to verbs of number and person is logically as anomalous as it is to assign gender and number to adjectives. Most languages fall into this error, which is, however, susceptible of a very easy historical solution. It arose, doubtless, from the original custom of annexing the pronoun to the termination of the verb, and continuing the use of the inflection after its import had been forgotten, and when the pronoun had been formed into an independent part of speech.

GRAMMAR, COMPARATIVE.—Although languages can be classified only according to the character of their grammatical forms, yet the principles by which these forms are developed run through all languages, in so far as they may be said to possess any grammatical system at all. Differences of grammar mark off the families of human speech by barriers which are never overpassed. A language may borrow from the vocabulary of another language, until, like the Araucan of America, it has more foreign than native words in its dictionary; but its grammar never changes. There can be no such thing as a mixed language, if by this term we refer to its grammar, and not merely to the words which it has moulded into its own shape. But vast though the differences of grammatical forms may be between one language and another, the same process of formation may be discerned in systems at first sight utterly opposed to each other. Thus the termination *-ing*, in such phrases as *I am going*, is proved to belong, not to the present participle, but to the locative case of a verbal substantive. The same result is obtained by examining the so-called present participles in French, which the French Academy decreed in 1679 should no longer be declined. This decree, in fact, merely affirmed that such words were not participles at all, but the oblique case of a verbal noun. The Bengali exhibits the same process, the so-called infinitive being formed by *-te*, which is also the termination of the locative singular; and hence karitechi, *I am doing*, answers exactly to the old English idiom, *I am on doing*. Languages not belonging to the Aryan family show the operation of the same principle. In the Basque, the locative is formed by the suffix *an*. This suffix appears again in the present indicative, so that erorten niz, *I fall*, is literally, 'I am a-falling, or in the act of falling.' [FUTURE TENSE.] Other instances of the same kind may be found in Professor Max Müller's *Lectures on Language*, second series, p. 30, &c.; the conclusion forced upon us by all being that though the materials are different, the system is throughout the same. The disposition of these materials furnishes the real criteria of classification, which will be examined more at length in the article LANGUAGE. The reduction of languages into families and groups by the analysis of their system of construction is the office of comparative grammar.

Grammarian. Literally, one versed in grammar; but the term was used by the classic ancients as a title of honourable distinction for all who were considered learned in any art or faculty whatever. (Vossius's work on Grammar.)

Grammatite. The name originally given by Haüy to the mineral usually called *Actinolite* or *Amphibole*.

Gramme. The French integer of weight = 15·432 English grains. [WEIGHTS.]

Grammite. A mineralogical synonym of the variety of bisilicate of lime, commonly called *Tabular spar* or *Wollastonite*.

Grampus (a catachrestic form of the Fr. grand poisson, *large fish*). The *Delphinus orca*, or thresher, a large species of Arctic dolphin, which is frequently found on our northern coasts.

Granade. [GRENADE.]

Grand Jury. [JURY.]

Grand Serjeanty. [FEUDAL SYSTEM.]

Grandee (Span. grande de España). The highest title of Spanish nobility. The collective body of the higher nobility in Spain is termed *la grandeza*. They were originally the same with the *ricos hombres*. Grandees bear different titles—duke, marquis, &c.; but there is no essential difference of rank between these titles: all are equal among themselves. Grandeeships descend through females, and thus become accumulated in families.

Grange (Fr.; Ital. grangia, from Lat. granum). A farmyard or farmery, which consists of a farmhouse and a court of offices for the different animals and implements used in farming, and also of barns, feeding houses, poultry houses, &c. [FARMERY.]

Granite (Ital. granito, as formed of *grains*). The name popularly given to a large group of rocks consisting of crystals, generally of felspar and mica or some allied minerals, embedded in quartz. Crystals of quartz, mica, hornblende,

or talc embedded in felspar would have the same general name.

Great confusion has arisen in geology from the indefinite use of this term. Rocks of different ages, in different geological positions, have been considered identical; and all the older crystalline rocks, besides some of the newer ones, have often been described under the same name.

It has been a question whether granite is strictly an eruptive rock that has once existed in a fluid state. There appear to be many cases in which this is proved by experiment and observation. On the whole it seems probable that it is a rock, formed at great depth and under enormous pressure, consisting of many ingredients, and sometimes even containing water; and that it has often been pressed into veins and narrow fissures, where it has crystallised.

Most granites are hard, compact, and durable, and often mark the central axis of a mountain chain. There are, however, some varieties, which decay with comparative rapidity. De Luc talks of the *friable granite* of the Harz, and Saussure describes the mouldering down of that of the Alps. The waters of the Arve are rendered turbid by the pulverulent felspar that comes from the Aiguilles de Chamouny and other points that border the Mer de Glace. The road across Dartmoor from Ashburton to Chagford traverses, in one place, such loosely compacted granite as to resemble a bed of gravel. The granite of the Carglaise mine, near St. Austel, is so soft and pulverulent, that the excavation might almost be taken for a chalk pit; and near that mine there are immense quantities of white porcelain earth, or *kaolin*, of similar origin, due to the perishable nature of the felspar, which, giving way, suffers the grains of quartz and mica to fall out. Chemical analysis points to the loss of the alkali of the felspar as the cause of this extreme proneness of some kinds of granite to decay. Independent, however, of chemical composition, the mechanical texture influences their relative durabilities. When the arrangement of granite resembles that prevalent in the greater part of Cornwall, water gradually penetrating between the blocks and into the natural joints of the stone freezes there, and thus slowly removes the granite into gravel. The more solid texture of other varieties of granite prevents the decay referable to that powerful cause.

Under the term *granitic formation* are sometimes included not merely granite properly so called (which is a crystalline aggregate of quartz, felspar, and mica), but the other rocks into which it merges, either from the predominance of one or other of its ingredients, from the loss of one or other of them, or from the occasional addition of some new mineral. These will be described in various articles, each under the name most generally given to it.

The largest granite tract of England is that of Devon and Cornwall, where its sides are covered by slate, but where it rises in several places to the surface; it also forms the rocky promontory of the Land's End. Dartmoor forms a large mountain tract of nearly 80,000 acres in extent, strewed with boulders and fragments, which appear to set cultivation at defiance. The highest point of this district, near Okehampton, is 2,070 feet.

Granite is widely spread, and many large tracts are entirely made up of it. Where it decomposes readily, it passes into a good soil, not naturally rich, but capable of becoming so by the addition of organic matter. In other places it rises into lofty and picturesque peaks of mountain, forming the most magnificent scenery in the world.

Granivorse (Lat. granum, *a grain*; voro, *I eat*). The name given by Temminck to an order of birds, including the Insessorial species which feed on grains: other animals with a similar diet are termed *granivorous*.

Grant (perhaps another form of *warrant*, *guarantee*, &c.: Mr. Wedgwood, *Eng. Etym.* s. v. connects the word with Lat. *gratus* and *credentia*). In Law, a mode of conveyance by deed, now the common method of transferring land, and all other descriptions of real property of freehold tenure (stat. 8 & 9 Vict. c. 106).

Granulation. The method of dividing substances into grains or drops. With the metals it is usually effected by pouring the melted metal into water; if fine division is required, it must pass through a perforated ladle or sieve; and in order to obtain spherical particles, it must fall from such a height as to become solid before it meets with the water; hence the height of the towers in which *shot* is made. Another form of granulation is that practised upon certain pasty substances, as seen in the *globules* of the homœopathists, and in some effervescent remedies which in consequence of their granulated form are more slowly acted upon by water than when in fine powder, so as to render the effervescence more gradual.

Granulations. This term is applied to the little granular formations which arise in sores that are healing, and by which the destroyed parts are filled up and the edges brought together. When healthy, they are of a red colour, not exuberant; when unhealthy, they are pallid, and become soft, spongy, and irregular.

Grape (Ital. grappo, as growing in bunches or *handfuls*). The fruit of the Vine, *Vitis vinifera*. Grapes are useful not only in the fresh state as one of the foremost of dessert fruits, and in the dried state as raisins [CURRANT], but as furnishing the material for the manufacture of wine. [WINE.]

Grape Disease. [OÏDIUM.]

Grape Shot. In Artillery, consists of a number of cast-iron balls, arranged in three tiers by means of circular plates, the whole secured by a pin which passes through the centre. The number of shot in each tier varies from three to five. It is very destructive up to 300 yards, and effective up to 600 yards but not farther.

Grape Sugar or **Glucose** ($C_{12}H_{14}O_{14}$, or $C_{12}H_{12}O_{12} + 2HO$). This modification of sugar abounds in grapes, figs, plums, and other fruits: it is also the result of the action of *diastase*, and of dilute acids upon starch. In good seasons the expressed juice of grapes yields from thirty to forty per cent. of solid matter, the greater part of which is this kind of sugar. When obtained from fruits, it is generally accompanied by more or less of an uncrystallisable sugar, called *Fruit-sugar* or *Fructose* ($C_{12}H_{12}O_{12}$), which, by assimilating the elements of water, passes into the condition of glucose. The conversion of starch into this kind of sugar is a process extensively carried on as a commercial manufacture. Potato-starch and sago are principally used: they are saccharised by the action of dilute sulphuric acid (10 parts of acid to 1,000 of water and 500 of starch). The dilute acid is heated by steam, and the starch, previously mixed with water of a temperature between 112° and 130°, is suffered gradually to dribble in under constant stirring; in about two hours and a half the whole of the starch is added, and in from fifteen to twenty-five minutes afterwards the saccharification is complete; the steam is then shut off, and the liquor transferred to another vat, in which the acid is saturated with chalk. When the sulphate of lime has subsided, the clear liquid is drawn off and evaporated to the specific gravity of about 1·26. The resulting syrup is then left to deposit the sulphate of lime separated during evaporation, and afterwards drawn off perfectly clear. In this state it may be used as a source of alcohol, or for sweetening coloured liquors; but it requires, for some purposes, to be deprived of colour, which is done by filtering it through animal charcoal. When required in its solid state, the syrup is evaporated in a steam vat till of a specific gravity of about 1·4, and then poured into coolers, where it concretes.

Glucose differs from sucrose, or cane-sugar, in being less soluble in water, and more soluble in alcohol, so that the two may be to some extent separated by the action of alcohol. The sweetening power of glucose is also greatly inferior to that of sucrose, 2 parts of the latter being in this respect equivalent to about 5 *of the former. Sucrose easily crystallises in prisms, but glucose forms tubercular concre*tions, or fibrous acicular groups, $= C_{12}H_{12}O_{12}$, 2 HO. Both these sugars form definite crystallisable compounds with chloride of sodium.

Graphic Acid. A yellow crystalline body, resulting from the continued action of sulphuric acid and chlorate of potash on graphite.

Graphic Gold, Graphic Tellurium (Gr. γράφω, *I write*). Mineralogical synonyms for Sylvanite, having reference to the particular appearance produced by the aggregation of the capillary crystals, which are frequently arranged in rows more or less like graphic delineations.

Graphite. This substance, under the name of *Black Lead* and *Plumbago*, is well known in the manufacture of pencils, for which purpose it was chiefly obtained from the mine of Borrodale, at the west end of Derwent Lake in Cumberland, where it was first wrought during the reign of Elizabeth; but this locality is now nearly worked out. It has lately been found in enormous masses in North-eastern Siberia. In a less pure state, it is not an uncommon mineral, occurring in detached masses, generally in primary rocks. It is thus found in Germany, France, India, Ceylon, and North and South America. It is of an iron-grey colour, metallic lustre, and soft and greasy to the touch, producing a leaden mark on paper. Its specific gravity varies from 1·9 to 2·5: it occasionally occurs crystallised in hexagonal plates; it conducts electricity, and for this purpose is much used in the electrotype process. It is infusible, very difficult of combustion, and when mixed with fire-clay is a useful ingredient in the manufacture of crucibles and melting-pots intended to withstand high temperatures. It undergoes no change in air, and is used to cover articles of iron to prevent rust, and also for lubricating machinery. When burnt in a stream of oxygen gas, it leaves a residue of yellow ash, composed chiefly of oxide of iron, with silica and titanic acid, but varying in quantity in different specimens. In good plumbago, the carbon amounts to 96 per cent. The oxide of iron is an incidental ingredient, and is not in chemical combination with carbon. Brockedon found that the dust of plumbago might be forced, under great pressure (like spongy platinum), into a coherent mass, which might be cut and applied to the same uses as the native substance; and Brodie has patented a process for the purification of ordinary graphite. Some kinds of cast iron, after long immersion in sea-water, leave a substance which has some of the characters of graphite.

Graphotype. A recently discovered mode of producing engravings for working as woodcuts by letterpress, the principal value of which is that it needs no engraver to interpret the work of the artist. It is said that the cost of graphotypes is about one-tenth that of wood engravings. The process is thus described: A layer of prepared chalk is compressed by hydraulic pressure upon a plate until the surface of the chalk is as smooth as a sheet of paper. The artist draws on this surface with *an ink which has the property of making the chalk which it touches harder than the re*maining surface. A soft brush or a piece of velvet is now rubbed over the plate, from which it removes part of the untouched chalk, leaving the inky portion in relief. When these lines are considered deep enough, the whole plate is saturated with a chemical solution, which hardens the chalk. From this, *impressions* may be taken direct, or stereotypes or electrotypes may be obtained as soon as the stone is dry. Some graphotypes are said to rival in beauty and delicacy the best engravings.

Grapnel. A small anchor of several claws, used in mooring boats and small craft: also employed in close action between ships for the purpose of seizing the rigging of the adversary.

Graptolitidæ (Gr. γράφω, *I write*, and λίθος, *stone*). These fossil bodies, which have been found throughout the Silurian deposits, have been placed provisionally in the class *Polypi*. The axis of the polypary is sometimes straight, sometimes spiral, and serrated either on one or two sides. They occur in argillaceous strata, and it has been conjectured on good grounds that they presented a more generalised structure, nearer to the ideal type of *Polypi*, than the specially differentiated Sertularians and Pennatulidæ of the present day.

Grass Land. In Agriculture, land kept perpetually under grass, as contrasted with land which is alternately under grass and tillage. Perpetual grass lands are generally such as from the soil and situation are too moist to be ploughed with advantage, or too hilly and irregular on the surface to be ploughed at all. Hence we have hill pastures, and low moist meadows. The former admit of very little improvement, excepting that of drainage, and occasionally, in low hills, of irrigation; while the latter may not only be drained, but may be manured, and in some cases irrigated. [PASTURE; MEADOW; IRRIGATION.]

Grass-oil. Some of the *Grasses* yield odorous volatile oils, as the *Anthoxanthum odoratum*. The *Andropogon citratum* yields the oil of *lemon-grass*, much used in perfumery under the name *oil of verbena*; and the *grass-oil of Namur* is distilled from the *Andropogon calamus aromaticus* or *nardoides*.

Grasshopper. [LOCUST.]

Grauwacke. A name given by the German geologists to a peculiar variety of fissile sandstone, consisting of small fragments of quartz, flinty slate, and clay slate, all cemented into a kind of stone by argillaceous matter. Occurring only in a fixed geological position in Germany, or at least being abundant in that position, it was long regarded as an important rock among those assumed not to contain fossils. Like other mechanical rocks, it has no necessary limit of age, if regarded as a mineral type. Most of the deposits so called have since been found to contain fossils, and belong to all periods. [WACKE.]

Grave. In Music. [ALLEGRO.]

Gravel (Ital. gravella, Fr. gravelle). This name is generally given to any accumulation of rounded pebbles with sand. Almost all matters so called are of tertiary origin; but gravels may exist of any geological period. All the best gravels of England were formed and deposited during that period when the country was covered by glaciers or swept over by icebergs, and thus gravel and *glacial drifts* are almost synonymous. [GLACIAL DRIFTS.]

Gravel is distributed in patches over England, and often in thick beds, having some appearance of stratification, and containing animal remains. Among these, human remains have been found in France and parts of England, showing that human beings must have overspread Western Europe when the land was in a very different form, and when its quadrupedal inhabitants included elephants and rhinoceroses. [FLINT IMPLEMENTS.]

Large quantities of pebble beds used as gravel, occur in the lower tertiary deposits of England. Where true gravel does not exist, decomposed granite is often known by the same name, but it is a poor substitute. Even broken shells are often used near the seaside for some of the purposes of gravel.

GRAVEL. In Gardening, gravel is an important article, being that of which walks are formed wherever it can be procured. In selecting gravel, two qualities are chiefly to be sought for; viz. a good colour, and the property of binding. The most common colour of pit gravel is a rusty brown; and that of river or sea gravel, a grey, with different shades of white, red, or brown. The best colour is a deep rich yellow, which is that of the gravel of Kensington, the stony parts of which are flints. The binding properties of gravel depend upon the presence of ferruginous clay, and the irregular and angular shapes and sizes of the stones. Where the stones are round or oval, with regular smooth surfaces, they never form a good binding gravel.

Gravel, Urinary. [CALCULUS and URINE.]

Graver, called also **Burin.** A sharp tool, with a triangular extremity, for cutting the lines of an engraving on the copper. [ENGRAVING.]

Graves or **Greaves.** The sediment of melted tallow, composed of the membranous, vascular, nervous, and muscular matters blended with the fat, and which, not being fusible, are easily separated from it by straining; they are made up into cakes, and sold by the tallow-chandlers, being chiefly used as a coarse food for large house-dogs.

Gravimeter (Lat. gravis, *heavy*, and Gr. μέτρον, *measure*). An instrument for ascertaining the specific gravities of bodies, whether liquid or solid. The particular instrument to which the term is usually appropriated was invented by M. Guyton, who adopted this name in preference to *areometer* or *hydrometer*, because the latter terms imply that the liquid is the thing weighed; whereas, when solids are weighed, the liquid is only the term of comparison to which the unknown weight is referred. [HYDROMETER.]

Graving Dock. A name given, in Hydraulic Engineering, to an enclosure made on the side of a river, or of the seashore, into which a vessel can be floated for examination and repairs. There are generally several graving docks attached to naval arsenals; and they are also in use for the mercantile navy, at Liverpool, London, Glasgow, Bristol, Hull, Havre, Marseilles, &c. A graving dock in general consists of the *lock* at the entrance, which may be closed either with gates or a pontoon; the *altars*, as the steps at the side are called, and the *floor*; the *pumping-engine*, and the *tar-melting place*. The dimensions given to graving docks at Woolwich are 265 feet in length, from the apex of the semicircular end

to the inside of the gate; the width at top 80 feet, at bottom 37 feet; the clear width of the entrance 65 feet; the height from the quay line to the upper side of the invert, 26 feet. The sides are, in this case, made in steps varying from 9 in. to 16 in. in height, and from 9 to 15 in. wide, excepting the broad altar, which is 18 in. wide. There are two staircases for the men at the entrance; one slip for lowering the materials at the head, and one on each side of the dock; the walls are, in this case, 4 feet thick at the top, and 25 feet 6 inches at the bottom.

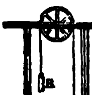
Of late, the authorities of some ports, as Havre, Carthagena, &c., have introduced a system of floating dock, instead of building a graving dock in the dry ground. These docks consist of a framework, in every respect analogous to the interior of the latter, which is sunk near the ship, and then raised by the pumping out of the water in which the ship floated. These can be advantageously applied wherever there is a large water surface to be disposed of, but they are not applicable when space is valuable, nor are they so convenient for the approach of materials. Perhaps the most ingenious substitute for the ordinary kind of graving dock is Clark's HYDROSTATIC DOCK, in which the ship is fastened on a platform sunk beneath its keel, and then the whole of the platform, ship and all, is raised out of the water by hydrostatic pressure, made to act upon pillars connected with the platform by suspension rods.

Gravitation, Gravity (Lat. gravis, *heavy*). These terms are often used synonymously to denote that mutual tendency which all bodies in nature have to approach each other, with forces which are directly as their masses and inversely proportional to the squares of their distances.

That every particle of matter in the universe has a disposition to press towards, and, if not opposed, to approach to every other, is a fact of which we derive the knowledge partly from our constant experience of what takes place at the earth's surface, and partly by reasoning from the observed motions of the celestial bodies. This mutual tendency of all the particles of matter to each other is called the *attraction of gravitation*. In reference to any particular body, or mass of matter, the aggregate attraction of all its particles is usually called simply its *gravity*.

Gravity, Terrestrial.—Universal experience demonstrates that all heavy bodies, when unsupported, fall towards the surface of the earth. The direction of their motion may be ascertained by a plumb-line; and it is found to be always perpendicular to the level surface of the earth, that is, to the surface of stagnant water. But the earth is very nearly spherical, and a line perpendicular to the surface of a sphere must pass through its centre; hence the direction of a body moving in consequence of the force of terrestrial gravity is towards the centre of the earth. And this is the direction in which it must move if the force of gravity is the resultant of the attraction of all the particles of terrestrial matter on the falling body; for it has been demonstrated (by Newton) that a sphere attracts an exterior body in the same manner as if all its matter were condensed into a single point at its centre.

As bodies when left without support fall from all heights to which they may be carried, it may be inferred that gravity acts on them during the whole time of their descent, and is therefore a uniformly accelerating force. This might also be inferred from the fact, which is easily rendered sensible, that bodies which fall from a greater height arrive at the earth with a greater velocity. But Galileo was the first who proved by experiment that the acceleration of falling bodies is uniform, and that the spaces through which they descend are consequently as the squares of the times of descent. Experiments of this kind are attended with some difficulty on account of the resistance of the air. In order to render this resistance insensible, Galileo caused bodies to descend on planes having a small inclination to the horizon, in which case (neglecting the effects of friction) the velocity is diminished in the ratio of the sine of the plane's inclination. By mounting the descending body on wheels, and forming the inclined plane of a hard substance capable of receiving a perfect polish, the friction may also be so much diminished as not to change the nature of the motion. But the best method of showing experimentally that gravity is a uniformly accelerating force is by means of an apparatus called (from its inventor) *Attwood's machine*. This consists of a pulley, the axle of which turns on friction rollers, and having a groove on its edge to receive a string. Over the wheel a fine silken cord is stretched, to the ends of which are attached two equal weights, A and B. In this state the weights counterbalance each other, and no motion ensues;



but if to one of the weights a small weight m be added, the combined weights will immediately begin to descend. The motion which now takes place is exactly of the same kind with that of a body descending freely; but the velocity is diminished in the proportion of the additional weight m to the sum of the three, m, A, and B; for the force, which is impressed by the additional weight, is expended in giving velocity not only to it, but also to the two weights A and B attached to the string. By this machine the properties of uniformly accelerated motion are experimentally shown to hold true in the descent of falling bodies; for if the additional weight be such as will carry the weight to which it is added through 1 foot in the first second of time, it carries it through 4 feet in 2 seconds, through 9 in 3 seconds, and so on. A proof is therefore afforded by this means that terrestrial gravity is a uniformly accelerating force.

Terrestrial gravity acts equally on all bodies;

that is to say, impresses on all of them an equal quantity of motion, whatever their nature may be. This property of gravity was also demonstrated by Galileo. In different hollow spheres, of equal weight and diameter, he enclosed equal weights of different substances: the spheres were suspended by strings of equal length, and made to vibrate in very small arcs, when it was found that the time of an oscillation was the same in all of them. Common experience would seem to be at variance with this result. Light bodies, as feathers, paper, &c., fall slowly and irregularly; and some substances, as smoke, vapours, &c., even ascend. But this, as is well known, arises from the buoyancy of the atmosphere. In the exhausted receiver of an air-pump a piece of gold and a feather fall with the same speed, and strike the bottom at the same time.

Gravity, Terrestrial, Measure of.—Having ascertained the law according to which gravity acts on bodies at the surface of the earth, the next question is to determine its absolute intensity, or the velocity which it communicates to a body falling freely in a given time. On account of the rapidity of the descent of heavy bodies, this cannot be done by direct experiment; nor could Attwood's machine be employed for the purpose with sufficient certainty. The only mode by which an accurate result can be obtained is by measuring the length of a pendulum which makes a given number of oscillations in a given time. Let l be the length of the seconds' pendulum, π the ratio of the circumference to the diameter, and g the accelerating force of gravity, that is twice the space through which a body falls by the action of gravity in the first second of time; then [PENDULUM] we have the equation $g = l\pi^2$. Now the length of the pendulum vibrating seconds of mean solar time in London, in vacuo, and reduced to the level of the sea, has been determined to be 39·1393 British standard inches; and $\pi = 3{\cdot}14159$; therefore g is found $= 386{\cdot}3$ inches, or $32\frac{1}{5}$ feet. The height, therefore, through which a body would fall in vacuo in a second of time at London is half of this quantity, or $16\frac{1}{10}$ feet. It will be observed, however, that this value of g does not express the whole of the earth's attraction, a small part of which (about the 1-464th) is counteracted by the centrifugal force corresponding to the latitude: it is the force of gravity diminished by the centrifugal force, or what is properly called *gravitation.*

From experiments made with the greatest care, it appears that the extreme amount of the variation of the gravitating force between the equator and the poles is one part in 194 of the whole quantity; that is to say, any body which at the equator weighs 194 pounds, if transported to the pole would weigh 195 pounds. The difference of gravitation, therefore, at the equator and the poles, is expressed by the fraction $\frac{1}{194}$. Now it has been demonstrated by Newton that the ratio of the centrifugal force at the equator to gravitation there is $\frac{1}{289}$. This is considerably smaller than the fraction $\frac{1}{194}$; but the difference, which is $\frac{1}{590}$, arises from the oblate figure of the earth, in consequence of which a body placed at the pole is at a less distance from the centre than one at the equator, and is therefore attracted more than it would be at the equator, even if the earth stood still, and there was consequently no centrifugal force. From this it may be readily understood that the figure of the earth is determinable by measuring the intensity of gravitation under different latitudes. [DEGREE; EARTH.]

Gravitation, Universal.—Galileo, who had so fully succeeded in exploring the nature of terrestrial gravity, did not suppose that its action extended to bodies beyond the immediate vicinity of the earth. The more speculative genius of Kepler led him to speak of gravity as a force acting mutually from planet to planet, and particularly from the earth to the moon; and he even supposed the tides to be produced by the gravitation of the waters of the sea towards the moon. He did not, however, suppose it to have any concern in the regulation of the celestial motions. Hooke also supposed the heavenly bodies to have a gravitation to each other; but his notions respecting its nature were inaccurate, and he did not attempt to define the law of its variation. This great discovery was reserved for Newton. While meditating on the nature of this force, the thought occurred to him that since gravity is a tendency not confined to bodies on the very surface of the earth, but reaches even to the summits of the loftiest mountains without its intensity or direction suffering any sensible change, may it not reach to a much greater distance, and even to the moon? Before this question, however, could be answered, it was necessary to suppose a law according to which its intensity diminishes. Newton soon perceived that this law would require the force of gravity to diminish exactly as the square of the distance increases; or that the attractive force of the earth at the distance of the moon must be as much less than it is at the surface of the earth, as the square of the radius of the earth is less than the square of the moon's distance from the earth. In a general way, the hypothesis is easily verified. The moon's orbit differs not much from a circle whose radius is equal to 60 times the semi-diameter of the earth, and the circumference of her orbit is therefore about 60 times the circumference of a great circle of the earth. Now the diameter of the earth being nearly 8,000 miles, and the period of the moon's revolution being 27 d. 7 h. 43 m., it is easy to compute that the versed sine of the arc described by the moon in a minute (which is the same as her deflexion from the tangent or straight line which she would describe if there were no force attracting her to the earth) is $16\frac{1}{10}$ feet. But the mean distance of the moon from the earth being 60 times the distance of heavy bodies at its surface from its centre, and her gravity increasing inversely as the square of the distance, her gravity would be 60×60 times greater at the surface of the earth than

at her present mean distance, and therefore would carry her through 60 × 60 × 16·1 feet in a minute near the surface. But by what was proved by Galileo respecting the descent of heavy bodies, the same force would carry her through 60 × 60 times less space in a second than in a minute; and therefore the same force which compels the moon to move in her orbit about the earth, supposed to vary according to the inverse square of the distance, would cause her to fall, near the surface of the earth, through 16·1 feet in a second. Now this is exactly the space through which heavy bodies descend in a second; therefore the moon *may* be retained in her orbit by the power of terrestrial gravity.

Newton, however, did not allow the argument for universal gravitation to rest on loose considerations of the lunar orbit as a circle described with an average velocity about the earth. He demonstrated that bodies moving under the influence of an attractive force which diminishes according to the inverse square of the distance must describe conic sections having a focus at the centre of force, and observe the laws of motion which Kepler had discovered to belong to the planetary orbits. He succeeded also in proving that some of the principal inequalities of the lunar and planetary orbits are necessary consequences of the mutual gravitation of the different bodies of the system to each other; and that the same mysterious power not only regulates the motions of all the planets and satellites in space, but also determines the figure of the earth, causes the precession of the equinoxes, and produces the tides of the ocean.

Assuming the different bodies which compose the solar system to be acted upon by their mutual gravitation, according to the law proposed by Newton, namely, that each body attracts every other with a force proportional to its mass directly and to the square of the distance inversely, the determination of the motions of the several planets and satellites becomes a question of pure geometry when the requisite data are determined by observation. If, however, the problem were required to be solved in its most general terms, and it were necessary to consider simultaneously the effects of all the bodies in the system, the difficulties of calculation would be enormous, and in fact no methods of analysis hitherto discovered would be sufficient to grapple with them. Fortunately the actual condition of the system is such as to afford great simplifications. The principal planets are isolated in space, at great distances from each other, and their masses are very small in comparison with the mass of the central body; so that the effects of their mutual attractions are not such as to alter the general elliptic form of their orbits, but merely produce small *perturbations* of their orbits and motions, which admit of being separately computed. By availing themselves of these favourable conditions, mathematicians have succeeded in expressing the whole of the complicated movements of the planets and satellites by analytical equations; and such is the perfection to which this branch of physical science has attained, that there is no irregularity in the motions of the bodies of the solar system, no deviation from their mean state appreciable to the most delicate astronomical observations, which has not been explained, and its period and amount accurately calculated on the principle of universal gravitation, according to the law discovered by Newton. [PLANET.]

The effects of gravitation, as manifested in the influences of the celestial bodies on each other, enable us to form several conclusions respecting its nature and mode of action. That gravity belongs not only to matter in the aggregate, but to every particle of which bodies are composed, is rendered evident by the manner in which the moon disturbs the waters of the ocean. Let E be the earth, and M the moon. If the moon's gravity acted only on the aggregate mass and not on each particle, it would have no effect on the

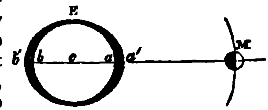


figure of the earth, and consequently no tide would be produced. But the action of the moon on the different parts is unequal. Those at a, which are nearest the moon, are more attracted than those at the centre c; which again are more attracted than the parts at b, which are farthest from the moon. The consequence is, that a fluid particle at a is drawn away as it were from the general mass, and an accumulation takes place at a'. For the same reason, the attraction at c being stronger than at b, the mass of the earth is drawn away from the parts at b, and the fluid is in a manner left behind, and accumulates at b'. Hence we perceive the reason why it is high water on opposite sides of the earth at the same instant of time. In fact, in consequence of the moon's attraction, the fluids on the surface of the earth have a tendency at every instant to arrange themselves in the form of an elongated spheroid, the greater axis of which points towards the moon.

It is also proved by astronomical phenomena that gravity is a force which is transmitted from body to body, not successively, but instantaneously. Were gravity transmitted with a measurable velocity, the *rate* of velocity would sensibly affect the secular variation of the mean motion of the moon. By a comparison of the results of theory with observation, Laplace found that the velocity of the attracting force, if not infinite, must be at least *fifty millions* of times greater than the velocity of light. (*Méc. Céleste*, liv. xvi.)

Another question which may be put with regard to the nature of gravity is, whether its action is in any degree modified by the interposition of the substances through which it penetrates? For example, whether the attractive force of the earth, which must penetrate the whole substance of the moon before its influence reaches the particles on the opposite

side of that body, acts with the same intensity on those particles as on those nearest the earth, regard being had to the law of the distance? Now, if the attractive force suffered any diminution in passing through the lunar substance, the parallax would thereby be affected; but, from the amount of the parallax, it is certain that the intensity of terrestrial gravitation on the different molecules of the moon suffers no variation, excepting what arises from the different distances of the molecules. It may therefore be considered, says Laplace, as sufficiently established that the force of gravity is of so subtle a nature that the densest bodies of the universe offer no obstacle to its free passage.

A third conclusion is, that the law of gravity is not modified in any respect by the different natures of the celestial bodies. If the action of the sun on the molecules of the earth differed only by a millionth part from its action on the molecules of the moon, the difference would occasion a variation of the sun's parallax amounting to several seconds. But the supposition of any such variation is impossible. It follows, therefore, that the gravitating force of the sun, in equal times and at equal distances, impresses equal velocities on the earth and moon. It is also demonstrated from the theory of Jupiter and Saturn, that Jupiter acts on Saturn according to the same law as on his own satellites. Gravity is therefore a force altogether independent of the nature of the substances on which it acts.

Gravity, Centre of. [CENTRE OF GRAVITY.]

Gravity, Specific. The specific gravity of a body is the ratio of its weight to the weight of an equal volume of some other body assumed as a conventional standard. The standard usually adopted for this purpose is pure distilled water at a given temperature. In England the temperature is generally taken at 62° of Fahrenheit's scale; the French take it at 32°, or that of melting ice; sometimes at the temperature at which its density is the greatest (about 39·4° of Fahrenheit). The temperature of 32° is by far the more convenient, inasmuch as it can be easily maintained without variations; whereas it is hardly possible to perform experiments at the exact temperature of 62°, in consequence of the continual variations of the temperature of the air. It is only, however, when very great precision is required, that it is necessary to make the experiment with water at any particular temperature; in general it is sufficient to note the temperature, and apply a correction depending on the known density of water at the different degrees of the thermometric scale.

The most obvious method of ascertaining the *relative weights* or specific gravities of two different bodies is to immerse them successively in a cylindrical or prismatic vessel of a known area, containing a liquid of less density than either. When a solid is immersed in a liquid, the liquid occupies as much more space than it did before as is exactly equal to the bulk or volume of the body; and therefore by immersing equal or known weights of different bodies in a vessel of the form specified, the relation between the heights at which the liquid stands will give the relation between their densities. This was the method proposed by Archimedes for solving the famous problem of the crown of Hero.

The method now employed is susceptible of far greater accuracy. It depends on this principle, that a body when immersed in a fluid loses just as much of its weight as is equal to the weight of an equal volume of the fluid. To obtain the specific gravity of a solid body, therefore, its weight in air must be divided by the loss of weight which it sustains when weighed in pure water.

The process of finding the specific gravity of any solid body denser than water is rendered very simple by means of the *hydrostatic balance.* When the solid is less dense than water, its weight in that liquid cannot be ascertained directly; but it may be found by attaching the body to another sufficiently dense to cause both to sink.

In like manner, the specific gravity of a solid in the state of powder may be found by placing it in a vessel whose weight in air and in water has been previously determined.

The specific gravity of a liquid may be found in several ways by means of the hydrostatic balance. One way is equivalent to finding the ratio of the density of a suitable solid body first to water and then to the liquid to be experimented on.

Another method is to take a phial of known weight, and weigh it when filled with water; the increase of weight is of course the weight of the water. It is then filled with the liquid, and again weighed, and the weight of the contained liquid thus ascertained. We have then the weights of equal bulks of the water and the liquid, whence the ratio of their specific gravities is known.

For many practical purposes, and especially for determining the specific gravities or *strengths* of spirituous liquors, it is necessary to have recourse to more expeditious methods than that of the hydrostatic balance. In such cases the instrument called an *hydrometer* is employed. [HYDROMETER.]

The specific gravities of the gaseous fluids are usually determined in terms of that of atmospheric air. The difference between the weights of a flask when exhausted of air by means of the air-pump and when filled with the gas gives the weight of the gas which it contains. But experiments of this kind require to be made with great care, as they are much affected by small variations of the temperature, pressure, and hygrometric state of the atmosphere. For a detailed account of the method of proceeding, and the manner of applying the requisite corrections, see Biot's *Traité de Physique*, tome i.

Grayling. [SALMON.]

Grazioso (Ital.). In Music, an instruction to the performer that the music to which this

word is affixed is to be executed elegantly and gracefully.

Great Circle Sailing. In Navigation, the shortest distance between two places on the surface of the earth is the arc of a great circle passing through them. If the latitudes and longitudes of the two places are known, this arc may be readily calculated by the common rule in spherical trigonometry for finding the third side of a spherical triangle when the other two sides and the included angle are given. The practical inconvenience of sailing on a great circle arises from the necessity of continually altering the course; this, however, may be partly obviated by taking two or more points on the arc, and finding the latitude and longitude of those points; then, by the common rules of navigation, finding the course and distance from the place of departure to the nearest point marked on the arc: thence the course and distance to the next point, and so on. The sum of the distances described on these several courses will not differ much from the shortest distance. By proceeding in this manner as far as it is practicable, the advantage of sailing close to the arc of the great circle, and thus of shortening the distance, may be obtained without any difficulty. (Jeans' *Navigation.*)

Great Oolite. [OOLITE.]

Great Primer. In Printing, the name of a kind of type six sizes larger than that used in this work. [TYPE.]

Greaves (Span. grevas; in the dialect of Burgundy, grève still signifies *shin*). Pieces of armour for the protection of the leg. That they were generally used by the Achæan warriors in the Homeric age, is shown by their common epithet εὐκνήμιδες, or *well-greaved.* Examples found at Pompeii are of metal highly ornamented. In the fourteenth century they were made of metal or leather, and their Low Latin name was *bainbergæ*, from the German *beinbergen.*

GREAVES. [GRAVES.]

Grebe. [PODICEPS.]

Grecian Architecture. [ARCHITECTURE, GRECIAN.]

Greek Church, The. Comprises the great bulk of the Christian population of Russia and Greece, Servia, Moldavia, and Wallachia, besides various congregations scattered throughout the provinces of the Turkish and Austrian empires. Some of these acknowledge the patriarch of Constantinople as their head; others are under local patriarchs. The Byzantine patriarch, although possessing a certain spiritual supremacy over such an extensive community, has never ventured to assert any claim to the temporal power so long wielded by his rival at Rome. His ambition was curbed in the first instance by the jealousy of the emperors, with whom he was brought into closer contact; and since the Mohammedan conquest the state of weakness and poverty into which the Christian church in Turkey has been thrown has annihilated all views of aggrandisement. In earlier times, however, the Constantinopolitan pontiffs clearly showed that they did not lack the will to raise themselves to a station in the East on a level with the growing authority of the popes in the West. The origin of the separation which has now prevailed for many hundred years between two such important sections of Christendom as the Latin and Greek churches, agreeing as they do in most of their fundamental principles, is to be attributed to the rival pretensions set up by the bishops of the two imperial cities, and dates almost from the foundation of the younger capital.

As early as the year 451 the council of Chalcedon assigned Asia Minor, Pontus, Thrace, and the frontiers of Illyricum for the extent of the spiritual jurisdiction of the church of Byzantium, and conferred upon its bishop the honours and privileges which had been already conceded to the pope of Rome. The patriarchs of Antioch and Alexandria maintained at this period an independent authority; but were gradually reduced under the predominant influence of the patriarch of the East. The aggressions, however, of the rival pontiffs did not proceed pari passu: the Roman, being farther removed from the imperial authority, which was seated at Ravenna, assumed by degrees a direct temporal authority over the neighbouring districts; and this assumption led the way to the prodigious indirect supremacy which he usurped after the lapse of several ages. The Constantinopolitan, on the contrary, was always strictly watched, and fettered by the proximity of the Eastern emperors; and the extension or declension of the patriarchal authority depended in most cases more upon the particular character of the wearer of the crown than of the mitre. The first doctrinal ground of dispute was the assertion of the Latin church, about the beginning of the ninth century, of the double procession of the Holy Ghost from the Father and the Son. The word *filioque*, first surreptitiously inserted into the Constantinopolitan creed many years after its promulgation, became the badge of the Western church; but whatever apparent advantage this forgery might give to the opposite party, it is very certain that the other dogma, the procession from the Father alone, had never been declared by a council of the church.

The discussions produced by this controversy were brought to a head by the sudden elevation of Photius, a layman, to the patriarchate, by the command of the emperor. In six successive days he passed through the six preliminary orders: he became successively monk, reader, subdeacon, deacon, priest, bishop, and finally, on the seventh day, was consecrated patriarch; and all this to the violent exclusion of the existing pontiff, Ignatius. The appointment of Photius, who was a man of extraordinary talents, alarmed the Pope. The cause of Ignatius was supported in the West; and the intruder excommunicated by Nicholas I. The thunder of Rome was retorted by a charge, made on the part of Photius against the Latin church, of five distinct heresies. 1. It was objected that

the Romanists fasted on the Sabbath, or seventh day of the week; 2. That they permitted the use of milk and cheese in the first week of Lent; 3. That they forbade their priests to marry; 4. That they authorised bishops to baptise with the chrism, and forbade the priests; 5. That they had interpolated the creed of Constantinople with the word *filioque*, and held the doctrine therein implied.

These proceedings widened the breach which had already in fact taken place by the formal transference which the emperor had effected of several provinces east of the Adriatic, from the jurisdiction of Rome to that of Constantinople. The Romish party, however, continued still powerful in the East, and the intrigues of the papal see were frequently successful; until in 1054 the mutual excommunications pronounced upon each other by Leo IX. and Cerularius caused the final separation, which has continued to the present day.

The opinions of the Greek church bear considerable affinity to those of the Latin. The fundamental distinction is the rejection of the spiritual supremacy of St. Peter, and the denial of any visible representative or vicar of Christ upon earth. In the view which it takes of the procession of the Holy Ghost, it is at variance not only with the Roman Catholic church, but with the general belief of Protestants also. It recognises, however, the seven sacraments; authorises the offering of prayer to the saints and Virgin; and encourages the use of pictures, though forbidding that of images. It holds in reverence also the relics and tombs of holy men; enjoins strict fasting and the giving of alms, looking upon them as works of intrinsic merit; and numbers among its adherents numerous orders of monks and nuns, but allows, or rather insists on, the marriage of its secular priests. It holds that modified form of the Roman doctrine of the eucharist which is denominated *consubstantiation*; while it admits the doctrine of purgatory, and enjoins the offering of prayers for the dead. It administers baptism by immersion.

The distinctive characteristics of the Greek as contrasted with the Roman church are noticed by Dean Milman in the Introduction to his *History of Latin Christianity*. While the tendencies of the Western Church were chiefly practical, Greek Christianity was pre-eminently speculative, and ceased, with the extinction of Paganism, to be either creative or aggressive. The practical illustration of this difference is to be found in the remarkably stationary character of the discipline, usages, and modes of sentiment, not less than of the doctrines, of the Eastern church even to the present day.

The emancipation of the Russian branch of the Greek church from the centre of authority at Constantinople was gradually effected, and may be said to have been complete in the middle of the fifteenth century. The independence of the church of Greece Proper was recognised by Constantinople in 1850. (Stanley, *History of the Eastern Church*.)

Greek Fire. [FIRE, GREEK.]

Green Cloth, Board of. [HOUSEHOLD.]

Green Lead Ore. The native phosphate of lead.

Green, Scheele's. An arsenite of copper. *Mineral green* is a subcarbonate of copper, and *Brunswick green* an oxychloride of copper.

Green Sickness. [CHLOROSIS.]

Green Vitriol. The metallic salts of sulphuric acid were formerly designated *vitriols*: sulphate of iron was termed *green vitriol*. It is a compound of 1 atom of oxide of iron and 1 atom of sulphuric acid: the crystals contain 7 atoms of water; hence the crystallised salt consists of 36 protoxide of iron, 40 sulphuric acid, and 63 water, and its equivalent is $=139$. Sulphate of copper is called *blue vitriol*, and sulphate of zinc *white vitriol*.

Greenfinch. The *Fringilla viridis* of Linnæus. [FRINGILLA.]

Greenheart. The *Nectandra Rodiæi*, a tree of British Guiana, which furnishes a valuable wood known as Greenheart timber. It is also called the Bibiri-tree.

Greenhouse. In Gardening, a house with a roof and one or more sides of glass, for the purpose of containing exotic plants which are too tender to endure the open air during the greater part of the year. The greenhouse being a structure of luxury, ought to be for the most part situated near the house, in order to be enjoyed by the family in inclement weather; and, if possible, it should be connected with the flower-garden, as being of the same character with reference to use. Its length and breadth may be varied at pleasure, but its height should never be less than that of the loftiest apartments of the house to which it belongs. The best aspect is to the south or south-east; but any aspect may be chosen, provided the roof is entirely of glass, and abundant heat is supplied by art. In greenhouses facing the north, however, the more tender plants will not thrive so well in winter: more artificial heat will be required at that season; and the plants should be chiefly evergreens, and other plants that come into flower in the summer season, and grow or flower but little during winter. In most greenhouses the plants are kept in pots or boxes, and set on stages or shelves, in order that they may be near the roof, so as to receive the direct influence of the rays of light immediately on their passing through the glass. An orangery differs from a greenhouse in having an opaque roof, and in being chiefly devoted to plants, which, producing their shoots and flowers in the summer season and in the open air, are set in the orangery merely to preserve them through the winter. Such a structure might with more propriety be termed a *conservatory*; but custom in the present day has applied this term to buildings with glass roofs in which the plants are not kept in pots, but planted in the free soil, and in which a part of them are encouraged to grow and flower in the winter months. [ORANGERY and CONSERVATORY.]

Greenlandite. A variety of the precious Garnet.

Greensand. In Geology, the name given to two series of rocks belonging to the Cretaceous period and found below the chalk. The name is derived from the frequent presence, in these deposits of the cretaceous period, of particles of a silicate of iron of green colour, not unfrequently producing beds of sand of a greyish green tint. The greensands are divided into two groups, the *upper* and *lower*, the gault intervening. [UPPER GREENSAND and LOWER GREENSAND.] These names are not generally adopted by the continental geologists, owing to the absence of the characteristic colour in the representative formations. Thus the upper greensand forms a part of the chalk marl and is hardly distinguished from it, while the lower is commonly designated *Neocomian*.

It must not be assumed that a green colour always signalises the sands here described, or at any rate that it affects their appearance. They are frequently (especially the lower greensand) of the most brilliant and intense red. This is derived from the conversion of the grains of silicate into peroxide of iron, and is quite consistent with the presence of abundant green grains a little away from the surface.

Greenstone. A variety of trap-rock. The constituent parts of greenstone are hornblende and imperfectly crystallised felspar, the felspar being abundant. Augite sometimes replaces the hornblende, producing *dolerite*. [TRAP-ROCK.]

Gregarious (Lat. gregarius, from grex, *a flock*). In Zoology, those animals which are found in company with each other; used in opposition to *solitary*.

Gregorian Calendar. The reformed calendar of the church of Rome, introduced by Pope Gregory XIII. in 1582, in which the error of the civil year of the Julian calendar was corrected by the omission of three intercalary days in four centuries, and the moon's age, with the time of Easter, with the other movable feasts depending on it, indicated by the table of epacts. [CALENDAR.]

Gregorian Chant. Introduced by Pope Gregory the Great about A.D. 600. These chants have continued in use in the Western church to the present day, and form the basis of our cathedral music. (Hook's *Church Dictionary.*)

Gregorian Epoch. The epoch or time at which the computation by the Gregorian calendar commenced. This was in March, 1582.

Gregorian Telescope. The first and most common form of the reflecting telescope, invented by James Gregory, professor of mathematics in the university of St. Andrew's and afterwards of Edinburgh, and described by him in his *Optica Promota*, published in 1663. [TELESCOPE.]

Gregorian Year. The civil year of the Gregorian calendar. In the Gregorian calendar the common year consists of 365 days, and every fourth year is a leap year, or contains 366 days, excepting the last years of every century of which the number is not divisible by 4. Thus, the years 1700, 1800, 1900, are not leap years; but 1600 and 2000 are leap years, the numbers 16 and 20 being divisible by 4. The period is consequently 400 years, in the course of which there occur 97 intercalations; so that 400 years contain $365 \times 400 + 97 = 146{,}097$ days, and therefore one Gregorian year consists of 365·2425 mean solar days, or 365 d. 5 h. 49 m. 12 sec. But the true solar year consists of 365 d. 5 h. 48 m. 49·62 sec. The Gregorian year, therefore, errs in excess by 22·38 seconds; but the error is not worth taking into account, as it only amounts to one whole day in 3,866 years.

Gregorite. The Menaccanite of Cornwall, discovered by Mr. Gregor, whose name it bears. A variety of titanic iron-ore.

Grenade (Fr. from its resemblance to a pomegranate). A hollow ball of iron or glass, about two inches and a half in diameter, charged with gunpowder and furnished with a fuse; it is often called a *hand grenade*, being thrown by hand from the parapets of besieged places upon the invaders beneath.

Grenadiers (Fr.). The name given at first to the soldiers who threw grenades; but afterwards conferred on certain troops of the line, distinguished by peculiarities of dress, accoutrements, &c. The name originated with the French in 1667, but was speedily adopted into all the armies of Europe; and wherever it has been introduced, the finest men of a regiment have always been selected to form what is called the grenadier company. Until recently each regiment of the line in our service had a grenadier company; now the name only remains in the 'Grenadier Guards.'

Grès. The French name for a sandstone or a grit. Thus the new red sandstone is called *le nouveau grès rouge*; the grès of Fontainebleau is also a well-known member of the tertiary grès.

Gressorial. In Ornithology, is applied to the feet of birds which have three toes forward, two of which are connected, and one behind.

Gretna Green Marriages. In order to evade the stringency of the English Marriage Law, after the Act of George II., and to enjoy the facilities afforded by that of Scotland [MARRIAGE, LAW OF], couples from England used to have the ceremony performed at the first place which they could reach in Scotland. Gretna Green, on the western border near Carlisle, was the best known and most convenient. The ceremony merely amounted to an admission before witnesses that certain persons are man and wife, the only condition necessary to render it a valid marriage being that it should be either preceded or followed by cohabitation. This facility was abolished by 19 & 20 Vict. c. 96, which requires twenty-one days' previous residence to render such marriage valid. The number of these marriages was stated to be on the average 300 or 400 a year at Gretna alone; but with those which took place at other

places along the border amounted to about 500 a year.

Grewia (after Dr. Grew, a physiological botanist of the seventeenth century). Of this genus of *Tiliaceæ*, two species, *G. sapida* and *asiatica*, yield small red acid fruit, commonly used in India for flavouring sherbet. Some of the species have a fibrous inner bark, which is used for rope-making, &c.; and the wood of *G. elastica* is very strong and elastic. They are widely dispersed, but not found in America.

Grey Stone Lime. The name given by London builders to the lime made from the chalk marl quarried at Dorking, Merstham, or Godstone. It is of the same nature as the *clunch* lime of the midland counties; it is moderately hydraulic, containing about eight per cent. of the silicate of alumina. It swells a good deal in slaking, and gives out much heat.

Greywacke. [GRAUWACKE; GEOLOGY.]

Grias. The Anchovy Pear of Jamaica is the produce of *G. cauliflora*. The fruits are pickled and eaten like mangos. The genus belongs to the *Barringtoniaceæ*.

Griffin (Gr. γρὺψ). A fabulous animal represented with the body and feet of a lion, the head of an eagle or vulture, and as being furnished with wings and claws. The griffin belongs more to romantic than classical mythology. It plays a prominent part in the fairy tales and romances of the middle ages; and, like the dragon which was fabled to guard the golden apples of the Hesperides, its chief duties consisted in watching over hidden treasures, and in guarding captive princesses, or the castles in which they were confined. It has been adopted into the language of heraldry, where it constitutes a prominent feature in the armorial bearings of many princely and noble families.

Griffiths' Mixture. The *mistura ferri composita* of the London *Pharmacopæia*; it is a useful ferruginous tonic, deriving its efficacy from the protocarbonate of iron.

Grilse. [SALMON.]

Grimace (Fr.). In Painting and Sculpture, an unnatural distortion of the countenance, from habit, affectation, or insolence. The ancient comedians wore masks fashioned into the most exaggerated grimaces. (Ficoroni, *Le Maschere Sceniche &c. d'Antichi Romani*, Rome 1736.)

Grinders. [TEETH.]

Gripe. The fore foot of a ship.—*To gripe*, the tendency of a ship to bring her head up to the wind when carrying sail on the wind.

Gripes. On Shipboard, the apparatus of ropes, hooks, &c., by which boats are fastened to the upper deck during stormy weather.

Grisette (Fr.). Originally a dress of coarse grey cloth; but the word was afterwards applied to denote the women who wore them.

Gristle. [CARTILAGE.]

Grit (A.-Sax. greot). Any variety of stone made up of minute grains cemented together, may conveniently be called by this name. *Coal grit* is a sandstone of the coal measures; *calc grit*, a limestone of the oolitic series.

Groat (Dutch grote, originally grote schware, the *great* schware, as distinguished from the little schware, of which there were five in the grote or groat). An old English silver coin equal to 4*d*. of our present money. It was introduced by Edward III. about the year 1351, and has lately been again adopted and issued from the Mint: the first coinage of these modern silver groats or fourpenny pieces took place in 1835.

Groats. The seeds of Oats prepared as an article of food, by depriving them of their husks or hulls.

Groin. In Architecture, the line formed at the intersection of two arches which cross each other at any angle.

Grommet. On Shipboard, a ring or loop made at the end of a piece of rope by interplicing the strands.

Groningenists. In Ecclesiastical History, a subdivision of the sect of Anabaptists.

Groom (Dutch grom, *a youth*). A name now usually applied to servants who are employed about horses. The *groom-porter* was an officer of the royal household in the lord steward's department, whose place is said to have succeeded that of the master of the revels. Groom is still the denomination of several officers of the royal household, chiefly in the lord chamberlain's department; such as grooms in waiting, groom of the stole or robes, &c. &c.

Groove (Dutch, groeve, *a furrow*; Ger. grube, *a pit*, from graben, *to dig*). In Architecture, a sunken rectangular channel. It is usually employed to connect two pieces of wood together, the piece not grooved having on its edge a tongue, or projection, whose section corresponds to and fits the groove.

GROOVE. Every rifled firearm has two or more grooves, cut in a spiral direction in the interior of the barrel. The parts of the barrel between the grooves are called *lands*.

Gross. In Commerce, the number of twelve dozen.

Gross Weight. In Commerce, the weight of goods with that of the dust and dross, or of the cask, &c., in which they may be contained. Out of this weight the allowance is made for tare and tret.

Grossbeak. [FRINGILLA.]

Grossularia (Lat. grossulus, *a small fig*. A green garnet found in Siberia.

Grossulariaceæ (Grossularia, an old name of one of the genera). A natural order of shrubby Exogens, natives of most parts of the world, excepting Africa and the tropics, and distinguished among epigynous Exogens by their pulpy fruit and parietal placentæ. They were formerly confounded with *Cactaceæ*, and have been placed by Von Martius between *Saxifragaceæ* and *Onagraceæ*; but Lindley makes them the type of a distinct alliance. The Gooseberry, *Ribes Grossularia*, and the Currant, *Ribes rubrum* and *nigrum*, are well-known fruits of this order, to which also belong many beautiful hardy shrubs common in our gardens.

Grotesque (Fr.). In the Fine Arts, a term applied to capricious ornaments, which as a whole have no type in nature; consisting of figures, animals, leaves, flowers, fruits, and the like, all connected together. So called from being discovered in the ancient grottoes. [ARABESQUE.]

Grotto (Ital.). The name given to subterraneous natural excavations formed in the heart of mountains or other places. Many of these cavities are famed for the mephitic exhalations that issue from them, and to this class belongs more especially the Grotto del Cane, near Naples; but there are others not less celebrated for their beauty and grandeur, of which the grottoes of Antiparos and Fingal are well-known examples. In picturesque gardening, the term is applied to an artificial or ornamental cave or low building intended to represent a natural grotto.

Ground (Ger. grund). In the Fine Arts, a word of various application. In Painting, it is the first layer of colour on which the figures or other objects are painted. The term is also applied to the different distances in a picture, as fore-ground, middle-ground, background. In Sculpture, it is the surface from which, in *rilievi*, the figures rise. In Architecture, it is used to denote the face of the scenery or country round a building.

Ground Bait. Balls made of greaves, bran, boiled grain, gentles, &c., mixed up with clay and thrown into the water, by which the fish are brought together upon those spots which the angler selects for his sport.

Ground Gru or **Ground Ice.** Ice formed under peculiar circumstances at the bottom of running water.

The theory of the formation of ground ice is attended with some difficulty. Dr. Farquharson, who has carefully investigated the facts, and given the results of his observations on the ground gru of the rivers Don and Leschal in Lincolnshire, in two papers printed in the *Phil. Trans.* for 1835 and 1841, is of opinion that the ice is formed when the water has gone down to the temperature of the freezing-point in consequence of the bottom being cooled to a still lower temperature through the effect of radiation, in the same manner as dry land, under a clear sky, is cooled below the temperature of the air; and in corroboration of this opinion he states, that the formation never occurs excepting under a clear sky, and does not take place where the stream is shaded by bridges or high banks. It has been objected to this theory, that ground ice has been observed in the Neva under a thickness of three feet of surface ice, and an additional covering of three feet of snow, circumstances under which radiation could not take place; but Dr. Farquharson remarks, that this fact can form no valid objection to his explanation, unless it were ascertained that the ground ice was formed *after* the surface ice and fall of snow, and not before. Recent researches on heat have, however, rendered this hypothesis untenable, since it has been proved that water is absolutely intranscalent to rays of *obscure* heat such as those which Dr. Farquharson supposes to issue from the bottom of the stream. M. Arago, in the *Annuaire du Bureau des Longitudes* for 1833, after stating the observations which had then been collected on the subject, attributes the formation to three circumstances: 1. In a body of water in motion, the temperature of which is below 39° of Fahrenheit (under which water becomes specifically lighter by a further diminution of temperature), the eddies of the current throw down the coldest parts which, in still water, would remain at the surface, so that the whole stream from the surface to the bottom acquires the same temperature through this mechanical action. 2. The aptitude for the formation of crystals on the stones and asperities at the bottom. 3. Less impediment to the formation of crystals at the bottom, in consequence of the comparatively greater stillness of the water. On this subject see, in addition to the works above referred to, Colonel Jackson's paper on the Congelation of the Neva, in the *Journal of the Royal Geographical Society*; Mr. Eisdale's, in the *Edinburgh New Philosophical Journal*, vol. xvii.; Mr. Weitz's, on the Ground Gru of the Siberian Rivers, in the *London Geographical Journal*; Mr. Adie's and Prof. Frankland's on Ground Ice, in the *Journal of the Chemical Society*, vol. xiv. pp. 111 and 113.

Ground Plate or **Sill.** In Architecture, the piece of timber which forms the lower part of a timber building, into which the upright posts or principal timbers frame.

Ground Swell. An undulation of the ocean caused by the continuance of a heavy gale of wind. Ground swells are rapidly transmitted through the water, sometimes to great distances, and even in direct opposition to the wind, until they break against a shore, or gradually subside in consequence of the friction of the water. They indicate, by the direction of their movement, the quarter in which a storm has raged; and occasionally they are observed to come from various points of the compass at the same time.

Ground-tackle. The name applied on Shipboard to all the ropes, &c., connected with the anchors or other mooring apparatus.

Grounds. In Architecture, pieces of wood let in flush with the plastering, for which they serve as a guide; the mouldings and other finishings are nailed to them.

Groundsel. The common name for the genus *Senecio*, but more particularly applied to one of our commonest weeds, *Senecio vulgaris*, a plant used in feeding cage-birds.

Group (Fr. groupe). In Painting, an assemblage of objects, whose lighted parts form a mass of light, and their shaded parts a mass of shadow: the word is also used to denote any adjoining assemblage of figures, animals, fruits, flowers, &c. In speaking also of objects of different sorts, it is usual to say that one object *groups* with another. Lights in groups should,

as well as shadows, be connected together, or the necessary repose will be wanting. In Sculpture, the word *group* is applied to a design in which there are two or more figures. In Music, *group* signifies a number of notes linked together at the stems.

Grouse. [TETRAO.]

Grout. In Architecture, mortar reduced to a state of fluidity by the addition of water; also a mixture of plaster (or fine stuff) putty (or coarse stuff) used to finish off the best ceilings, and sometimes for setting walls when such finish is required.

Groynes. High timber defences erected on the exposed shores of the sea, or of rivers, when they are composed of such materials as can be easily removed by the action of the currents that may beat upon them. The term is also applied to the little jetties sometimes erected to defend the banks of rivers when threatened with destruction by the washing away of the shore. A groyne is, in fact, a projection that is carried out from the banks of the sea, or of a river, in a direction perpendicular, or occasionally inclined, to the set of the current; and it is supposed to act in the first case by retaining the shingle, which has a tendency to move in the direction of the prevailing wind; and in the latter, by diverting the channel in the direction required. Groynes are much used in the neighbourhood of Brighton, Dover, Harwich, Yarmouth, &c.; they are occasionally employed in river defences, as in the course of the Rhine, the Orne, the Midouse, &c.; but engineers have of late entertained the opinion, that they produce as much harm as good in these positions, by creating a backwater on the down side, unless they are so close together as to amount practically to a continuous parallel wall. (Minard, *Cours de Construction des Canaux et des Rivières, &c.*)

Gruidæ. The name of the family of wading birds represented by the stork (*Grus*).

Grummet Wad. In Artillery, a wad formed of a circle of rope, rather less in diameter than the bore of the gun for which it is intended, with two cross-pieces projecting a little beyond the exterior of the circle. These wads are used in firing cold shot from smooth-bored guns, when the elevation is less than 3°.

Grus (Lat. *the Crane*). One of the modern constellations in the southern hemisphere. [CONSTELLATION.]

Gryllidæ (Lat. gryllus, Gr. γρύλλος, *a locust*). The name of the family of locusts, having the genus *Gryllus* for the type. [LOCUST.]

Grypanium (Gr. γρυπός, *curved*). In Ornithology, the *rostrum grypanium* is that form of beak in which the culmen is more or less carinated, and is so continued to the apex of the incurved maxilla.

Gryphæa (Gr. γρυπός). A genus of Ostracean Bivalves, remarkable for the curvature of the apex or beak of the shell; it is chiefly represented by fossil species, one of which, *Gryphæa virgula*, characterises the Kimmeridge clay, near Oxford, and the upper oolite of parts of France.

Gryphosis (Gr. γρυπός). A growing inwards of the nails.

Guaco. The South American alexipharmic, *Aristolochia Guaco.* The same property has also been attributed to *Mikania Guaco.*

Guaiacum (Guaiac, the Guiana name). This genus of *Zygophyllaceæ* comprises the tree which yields Lignum Vitæ and resin Guaiacum; the first remarkable for its hardness and ponderousness; the second used medicinally as a stimulant in chronic rheumatism, and as an alterative. This tree is called *G. officinale*, and produces pinnate leaves and very pretty blue flowers. The resin is obtained by notching the stem; it has some chemical peculiarities which distinguish it from the common resins, especially its property of becoming blue and green by the action of certain oxidising substances. (Brande, *Phil. Trans.* 1806.) Its constituent resins, and the products of its dry distillation, are also in many respects peculiar.

Guana (Port. corrupted from Iguana). The local name applied to a large American lizard, the *Iguana tuberculata*, or *Lacerta Iguana* of Linnæus.

Guanacho. [AUCHENIA.]

Guano. The dried dung of seafowl, which has accumulated for ages on certain tropical islands. It was introduced into English agriculture in 1840, and the importation, which amounted to 2,000 or 3,000 tons in 1841 and 1843, has varied from 100,000 to 300,000 tons per annum ever since. It is used at the rate of from one to three cwt. per acre as a top dressing for wheat and other corn crops; and it is also of great service as an addition to the farmyard manure for various green crops. Its use has prepared the way for the extension of the artificial manure manufacture: and the two together have almost revolutionised English agriculture, and greatly added to the productiveness of English soil. It is an excellent manure, abundant in nitrogenous compounds, which seem principally to consist of urate of ammonia, and of the products of the decomposition of that salt; but it is largely adulterated, and many samples come into the market which are spurious.

Guarana. The *Paullinia sorbilis*, a South American tree, yield seeds which, when pounded, made into cakes, and dried in the sun, form Guarana bread. Guarana is extensively used in Brazil, Guatemala, Costa Rica, and other parts of South America, as a nervous stimulant and restorative, and also as a material for making a refreshing beverage. The active principle of Guarana is said by Martius to be identical with theine; but, as far as is known, no other substance yields it so abundantly, the amounts being 5·07 per cent. as against good black tea, which yields 2·13, and coffee from 0·8 to 1·00. The Guarana is carried in the pocket of almost every traveller; and when required, a small portion is grated on a fish bone or scale carried for the purpose, and being added to water, is taken as a substitute for tea.

Guarantee. In Law, an undertaking to answer for the failure of another. By the Statute of Frauds, a person is not liable on a special promise in the nature of a guarantee unless a written agreement, or memorandum of such promise, shall be signed by the party making the promise, or some person lawfully authorised by him. See also 19 & 20 Vict. c 97.

Guard, the Imperial. Was formed by the emperor Napoleon I. in 1804, from a small corps of lifeguards (as they might be termed) which had served to defend the Convention, the Corps Législatif of 1795, the Directory, and afterwards the Consulate. Its augmentation and equipment became afterwards one of Napoleon's favourite pursuits. In 1809, he divided it into the old and new guard, and as soldiers could not be enrolled in the old guard except after serving four campaigns in the line with distinction or from the preparatory corps called the young guard, it was an institution of the highest military policy. In the end of 1812, the Imperial Guard, old and young, consisted of 56,000 men; and its further increase was only prevented by the calamities of the following years. At the Restoration, the soldiers of the young guard returned to the line; those of the old guard were formed into royal regiments. The Imperial Guard was revived by Napoleon III. in 1854, and portions of it took part in the Crimean war in 1855. It consists of infantry, cavalry, and artillery. The Russian imperial guard forms an entire corps d'armée, exceeding 50,000 in number.

Guard, National, of France. This famous institution was first devised by the Municipal Committee of Safety of 1789, which sat at the Hôtel de Ville, in Paris, before the taking of the Bastille. The corps which was then raised at first carried green colours, afterwards replaced by the tricolor. It was more fully organised by a decree of September 1791, to be raised by voluntary enlistment, both in Paris and the departments, in the proportion of one man out of every twenty citizens. The staff of the national guard was dissolved by the Convention after the 13 Vendémiaire (1795), and it was placed under control of the military authorities. Napoleon made of the national guard a species of military nursery, and large portions of it volunteered in 1813 to act beyond the frontiers. Under the Restoration the national guards were deprived of the privilege of choosing their own officers; and in 1827, in consequence of their public demands for the dismissal of the ministry (Villele's), they were dissolved. In 1848, they were reconstituted and enlarged to the number of 100,000. Their constitution was again entirely altered in 1852, and they were placed under government control. Every Frenchman is bound to this service from fifteen to fifty.

Guard, Yeomen of the. Were first raised by Henry VII. in 1485, and appear to have been the first standing military corps ever set on foot in this country. They were at first fifty men, armed with bows, but afterwards some carried halberds, and later arquebusses. These were exchanged for partisans (which they now carry) in the reign of William III. [BEEF-EATER.]

Guardian. In Law, he who has the custody of such persons as are incapable of directing themselves, and especially of infants. These may now be said (on the father's death) to be of five classes: 1. Testamentary, or appointed by will; 2. Customary, by local usage; 3. Ad litem, or appointed by a court in order to conduct legal proceedings; 4. By appointment of chancery; and 5. In tort or by intrusion, as when a person wrongfully intrudes in the management of an infant's estate, he must account in chancery as if he had been a guardian. The old kinds of guardianship at common law are too nearly obsolete to need recapitulation. In France, as in England, guardianship (tutelle) lasts until the full age of twenty-one, unless in case of marriage or judicial *emancipation*.

Guardian of Spiritualities. In Ecclesiastical Law, the person to whom the spiritual administration of a diocese is intrusted during the vacancy of the see.

Guardian of Temporalities. A person appointed by the king during the vacancy of a see to take care of the goods and profits of the same, and deliver an account to the Exchequer.

Guardians of the Poor. Officers appointed in each union, under the Poor Law Amendment Act, 4 & 5 Wm. IV. c. 76, to superintend the administration of that law. [POOR LAW.]

Guards (through the French garder, from the Teutonic weardian, *to ward* or *keep*). Troops attached to the person of the sovereign. Body-guards have been an inseparable accompaniment of monarchy from the earliest ages: the Assyrian and Persian monarchs employed them. The corps of Argyraspides, or silver-shields, were selected by Alexander out of the bravest men of his army. The Roman emperors had their Prætorian guard. Napoleon first created a small troop of body-guards, with the title of Guides, while he was yet only general, in his first Italian campaign. From this arose by degrees the great institution of the Imperial Guard. [GUARD, THE IMPERIAL.] In England, the guards (otherwise called *household troops*) consist of the life-guards, the royal regiment of horse-guards, and three regiments of foot-guards. The first English body-guards were embodied in 1485; the horse-guards in 1550; and the foot-guards in 1660. Many of the European sovereigns, before the French Revolution, had small corps of foreign troops which served in this capacity. Thus the French kings had, in early times, a body of Scotch guards, termed *archers*; at a later period, a body of Swiss guards, called the Cent-Swisses; and after the Restoration of 1815 several battalions of Swiss guards were organised for the same service. This system has almost disappeared, since the troubles of the Revolution have introduced a spirit at once more military and more national into the coun-

cils and populations of Europe. The pope still retains his Swiss guards.

Guardship. In a British port, a large ship of war on harbour duty appointed to protect the ships lying unarmed in the port.

Guava. The fruit of the *Psidium Guaiava*, of which two forms, called *pomiferum* and *pyriferum*, are known, and from the fruits of which a jelly is made in the West Indies. [PSIDIUM.]

Gudgeon (Fr. goujon). The common name of a small species of the Cyprinoid family of soft-finned fishes; having, like the barbel, cirri or feelers at the mouth, and both the dorsal and anal fins short, but without a strong bony ray at the commencement of either. The species consequently forms the type of a distinct subgenus called *Gobio*.

GUDGEON. On Shipboard. [GOODGEON.]

Gudgeons. Any short pin or bearing part of a piece of machinery. The laws of torsion are principally directed to ascertain the size to be given to these parts of machinery. (Hodgkinson, Tredgold, Rennie, &c.)

Guebers or **Guebres** (i.e. Giaours, *infidels*). The sectaries of the ancient Persian religion, of which the chief peculiarity is the worship of fire, are so termed by the Mohammedans. They still exist in some of the southern and eastern districts of Persia; and a colony of them, long established at Bombay and other parts of the western coast of India, has attained to wealth and distinction. These are termed in India *Parsees*, from the nation from which they originally sprang. The Guebres explain the worship of fire by professing to regard it as a symbol only of the Divinity. Their sacred books are termed the Zend-Avesta. [PARSEES.]

Guelder Rose. The *Viburnum Opulus* of botanists. It is remarkable for having the outer flowers of its cymes enlarged and neuter; in one variety, called the Snowball-tree, the whole cyme becomes barren, forming a globose head of snowy flowers. This variety is commonly planted in shrubberies, and bears the names of Rose de Gueldres, Pellotte de Neige, Boule de Neige, &c.

Guelf, Order of, or **Royal Guelphic Order.** An Hanoverian order of knighthood, founded in 1815 by George IV., then Prince Regent. It consists of grand crosses, commanders, and knights, both civil and military.

Guelfs. In Italian History, during the middle ages, a political party, the feuds between which and the opposite party of the Ghibellines long distracted the country. The former name is derived from that of the great German house of the Welfs or Guelfs. These, in the twelfth century, were dukes of Bavaria, who carried on war in Germany with the house of Hohenstauffen, from one of whose castles (Weiblingen) the name Ghibelline is supposed to have been derived. The latter house having become the ruling power in Germany under Frederick I., that prince invaded Italy in order to reassert the rights of the empire; and thus these party names, first used in a German feud, were transplanted into that country. The chief adversaries in Italy of the house of Hohenstauffen were the popes, who thus became the heads of the Guelf party; and in the thirteenth century, when Frederick II. was involved in contests with several successive pontiffs, the struggle between the two became a contest between the temporal and spiritual power. In that instance the latter prevailed; but the Ghibellines remained, notwithstanding, powerful, especially in the north of Italy; and, in the beginning of the following century, the invasion of the emperor Henry of Luxemburg added considerably to their power. In the early part of that century the leading Ghibelline powers generally were, Milan under the house of Visconti, Verona under that of La Scala, and the Aragonese kings of Sicily; the chief Guelf states, the republic of Florence, the Angevin kings of Naples, &c. Other states were alternately under the control of the two parties as they in turn predominated. At this time the poet Dante, who had embraced Ghibelline principles, not merely on party grounds, but from exalted political speculation, threw the lustre of his genius over the civil feuds of his age. In the course of the fourteenth century, especially after the removal of the papal seat to Avignon, the original principles of the two parties were entirely lost; while the names continued, and factions bearing those appellations constantly agitated the Italian cities and monarchies down to the middle of the fifteenth century, or even to a still later period. (Raumer, *Geschichte der Hohenstauffen*; Sismondi, *Républiques Italiennes*.)

Guenon. [CERCOPITHECUS.]

Guerilla (Span. *little war*). Petty warfare, carried on without a regularly organised army. The plan of harassing the French armies by the constant attacks of independent bands, acting in a mountainous country, was adopted in the north of Spain during the Peninsular War. It was first reduced into a kind of system in 1810. (Napier's *Peninsular War*, book ix. chap. i.) The bands which conducted this desultory warfare were called *partidas*: the name *guerilla* is, by a misapplication of the term, frequently applied to them.

Guide (Fr.). In Music, the leading part in a canon or fugue.

Guidon (Fr.). The flags or colours of dragoon regiments are called *guidons*. They are of silk, the first or royal guidon crimson, the regimental or second guidon the colour of the facings of the regiment. From Markham's *Souldier's Accidence*, 1645, we find that the guidon was the first flag of a commander of horse, who when he performed good service became permitted to carry a cornet, which was a guidon with the swallow-tail cut off, and if he was very gallant his cornet was cut square into a banner.

Guidones or **Guides.** A society of priests, established by Charlemagne at Rome, to conduct pilgrims to Jerusalem, and otherwise to help them in their pilgrimage.

Guilandina (after M. Guilandin). The

Guilandina Bonducella, an Indian tree, produces hard seeds called *nicker nuts*, which are strung into necklaces, rosaries, &c. The kernels are reputed to have tonic and febrifugal properties; as also the roots. It forms a prickly trailing tree of the Leguminous order.

Guild or **Gild** (Sax. gildan, *to pay*; perhaps from payments made by a member of a guild on admission). A fraternity or association, generally of merchants. The Collegia Opificum of the later Roman empire appear to have been societies of this kind, in which a body of artisans or traders exercising the same craft were united together for purposes of mutual assistance, and possessed what we should term corporate rights. The Anglo-Saxon guilds were voluntary associations for various purposes, religious and social as well as commercial. The oldest English guild of which the history is at all ascertained is said to have been the Cnighten guild of London, which has been thought by its name to have been a military company; but this is doubtful, and its history is extremely obscure. But the more important guilds of later times have been all mercantile. The guild-merchant, in many boroughs of England, seems to have been a trading society, into which all persons wishing to exercise trade within the borough were obliged to be admitted; and hence, in process of time, the freedom of the borough, which originally depended upon mere inhabitancy, became connected with admission to the guild, and the guild and corporate body of the borough became coextensive. A more remarkable change took place in the constitution of London, where the several trading companies by degrees so completely engrossed the government, that admission into one or the other of them (the liveried companies) became a necessary qualification for the exercise of municipal rights; while some relics still remain (such as the division of the city into wards) of the more ancient state of things. The name *guild* is still preserved in the ancient boroughs of Scotland, and the dean of guild is the second municipal magistrate of a Scottish borough. The zünfte of German cities, and the trading companies of those of France and Italy, have acted an equally important part in the history of those countries.

Guillemot. [Uria.]

Guilloche (Fr. guillochis). In Architecture, an ornament composed of curved fillets, which by repetition form a continued series.

Guillotine (Fr.). The name given to the instrument of capital punishment used in France; so called from Joseph Ignace Guillotin, by whom it was introduced into that country. This person was born at Saintes, and became a physician at Paris, where he obtained a certain celebrity in the early period of the Revolution by the strong part which he took in favour of the rights of the Tiers-État. He was in consequence elected a deputy to the National Assembly. When that body was occupied in its long discussions relative to the reform of the penal code (in 1790) Guillotin proposed the adoption of decapitation—up to that time used only for nobles—as the only method of capital punishment. From sentiments of humanity he recommended the employment of a machine which had been long known in Italy under the name of *mannaja*, and in other countries also; for something much resembling it had been used in Scotland [Maiden], and in England within the jurisdiction of the borough of Halifax. The Assembly approved the idea, and the machine was adopted, to which the Parisians have given the name of *Guillotine*, and of which Guillotin is most erroneously supposed to have been the inventor. It consists of two upright pieces of wood fixed in a horizontal frame; a sharp blade of steel moves up and down by means of a pulley in grooves in the two uprights; the edge is oblique instead of horizontal. The criminal is laid on his face, his neck immediately under the blade, which severs it at a blow from his body. It is equally a vulgar error that Guillotin perished by the instrument which bears his name. He was imprisoned during the Reign of Terror, but released at the revolution of July 1794; and died in 1814, after founding the association termed the Academy of Medicine. (See the articles on this subject in Croker's *Essays on the French Revolution*.)

Guinea. An English denomination of money; formerly a coin, but now disused. Its value is 21*s*. The coin weighed 129½ grains, and contained 118·7 grains of pure gold. Guineas were first coined in the reign of Charles II. (1662) of gold brought from Guinea; whence the name.

Guinea Hen. [Meleagris.]

Guinea Pepper. A species of *Capsicum*.

Guinea Pig. [Cavia.]

Guinea Worm. The *Filaria medinensis*. A worm which affects the skin, especially of the legs, in warm climates. Whilst it remains under the skin, this worm produces little uneasiness, till a part suppurates, and it puts out its head; much pain is experienced on attempting to draw it out, especially if it be broken.

Guisards. In Scotland, actors in masquerades, answering to the Morrice dancers of England.

Guitar (Lat. cithara, Gr. κιθάρα). A musical stringed instrument, the invention of which is attributed to the Spaniards. The strings are stretched over a body much larger than the violin, but of somewhat similar shape; the strings, which are more in number than in the violin, and are not carried over so high a bridge, are struck or pulled with the fingers.

Gula. In Architecture. [Gola.]

Gula (Lat.). In Zoology, the region of the throat nearest the lower jaw.

Guldin's Theorems. These theorems given originally by Pappus, and merely repro-

duced and verified by Guldinus in his work *De Centro Gravitatis* 1635–41, form the foundation of the so-called Barycentric method of determining the superficial area, and the volume of a surface of revolution. They may be thus enunciated:—

1. The area of the surface of a solid of revolution is equal to the rectangle under the generating arc, and the circumference of the circle which the centre of gravity of this arc describes. 2. The volume of a solid of revolution is equal to that of a prism, whose base is bounded by the generating curve, and whose altitude is the circumference of the circle described by the centre of gravity of the space which this curve encloses.

The demonstrations of these theorems were not given by Guldinus; they are, however, simple, and will be found in most treatises on Mechanics.

Gules (Fr. gueules; it is said from the red colour of gueule, *the throat*). In Heraldry, red; one of the colours, or tinctures, employed in blazonry. It is equivalent to ruby among precious stones, Mars among planets. In engraving, it is represented by a vertical line.

Gulf (Ital. golfo, Gr. κόλπος, Mod. Gr. κόλφος). In Physical Geography, a portion of the sea nearly enclosed by land. There is little essential difference between bays and gulfs, but the former name is more generally applied to deep indentations of the land whose opening towards the ocean is as wide as any part of the inlet, whereas gulfs have narrow entrances. Other great enclosed portions are called Seas [which see].

Of all gulfs, the gulf of Mexico is the most complete and characteristic. [Mexican Gulf.] It is the most nearly enclosed as well as the largest. The Persian gulf is large, and very nearly enclosed, lying between Arabia and Persia, and receiving the waters of the Euphrates. The gulf of Siam is much more open.

Gulf Stream. This name is given to a stream current, of extraordinary climatal importance to Europe, which comes out of the gulf of Mexico, between the islands off the coast and the peninsula of Florida, and thence within the Bahama bank, parallel to the American coast, until it meets the St. George's and Nantucket banks, when its course is deflected eastwards. After passing the southern extremity of the great bank of Newfoundland, it runs in the same direction to about 38° west longitude, within the parallels of 35° and 43° north. At this point the main stream turns to the south-east and south as far as the Azores, after which it is lost.

But although the main stream is thus deflected, its influence extends much further. Portions of it reach to Iceland, and wash the shores of the British islands, where tropical fruits have been sometimes landed; and there can be no doubt that the permanent influence of this current has produced the genial climate of Western Europe, as compared with the climate in corresponding latitudes on the west coast of the Atlantic, or on either coast of the Pacific.

The whole range of the Gulf Stream is estimated at about 3,000 miles in ordinary years. It occupies about seventy-eight days in its progress, the average rate of motion per hour being thus a little more than a mile and a half. The velocity, however, varies greatly, being as much as five miles an hour as it issues from the gulf of Florida, and not more than ten miles per day near the Azores.

The temperature varies, but the Gulf Stream is everywhere warmer than the proper temperature of the ocean at that point. As it comes out into the Atlantic, it is from 86° to 89° Fahr., and is only reduced to 84° when it has travelled ten degrees of latitude. After that, as it crosses the Atlantic it cools steadily, but always retains a part of its initial heat, and is constantly warmer than the ocean adjacent. The warm moist air over this current of hot water, when it is crossed by cold currents coming from the icy regions to the north, is at once converted into mist, and thus the course of the stream is in some parts marked by cloud and rain.

Parts of the Gulf Stream, nearer the American coast than the European, are sometimes actually crossed by icebergs, proving that the warm current is comparatively superficial, and that a cold current sets at right angles to the direction of the stream, near enough to the surface to govern the course taken by the larger and deeper icebergs.

Gulf-weed. The *Sargassum bacciferum*, which is found floating in the Atlantic, and occupying more than a quarter of a million of square miles. The origin of this mass of sea-weed has not been ascertained.

Gull. [Larus.]

Gulo (Lat. *a glutton*, from gula, *the gullet*). A genus of Plantigrade Carnivora, the type of which, *Gulo arcticus*, exists in the Boreal regions of the Old and New Worlds. Its fur, under the name of *wolverene*, forms an extensive object of commerce to the Hudson's Bay trappers. The grison (*Gulo vittatus*) and the taïra (*Gulo barbatus*) are found in South America.

Gum (Gr. κόμμι). A vegetable product, distinguished by solubility in water, and insolubility in alcohol; it is tasteless and inodorous. Gum arabic, which is the produce of the *Acacia vera*, may be taken as a sample of the purest form of gum. It is imported from Barbary and Morocco. Its specific gravity is 1·45. Its solution is viscid, and is termed *mucilage*. Gum is used as a demulcent in medicine, and for giving gloss and stiffness to linens, silks, &c. It consists of carbon 41·4, oxygen 52·09, hydrogen 5·51; or, in other terms, of 41·4 carbon and 58·6 water. [Tragacanth.]

Gum Resin. An exudation from many trees, composed of a mixture of gum and resin, or of a substance intermediate between the two.

Gum-tree. The popular name of *Eucalyptus*, an extensive genus of trees of the Australian continent, many of which furnish valuable timber.

Gun (for the origin of this word, see CANNON). Under this general term most of the species of firearms are included, the pistol and mortar being almost the only exceptions. Guns, or cannon, began to be used in Europe early in the fourteenth century; and in the accounts of Edward III. in 1346, there is mention of a *handgone*. The handgun was a barrel on a wooden stock, and was gradually developed into the musket. Muskets were at first of a very clumsy construction, being so heavy that they could not be levelled and fired from the shoulder; accordingly the soldier was provided with a rest, which it was necessary to carry along with him and plant in the ground in order to support the weapon before it could be used. The gun was generally fired with a match; sometimes by means of sparks generated by the revolution of a notched wheel of steel, placed directly above the pan containing the priming. Muskets with rests were employed so late as the civil wars in the time of Charles I.; afterwards a lighter matchlock musket came into use; and about the beginning of the last century the troops throughout Europe were armed with firelocks.

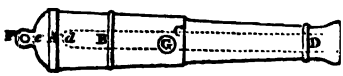
The barrel forms the essential part of the gun; and the first requisite to a good barrel is strength in the material of which it is made, for safety in using it depends mainly on this quality. Old horse stub-nails are much in request for the formation of musket barrels, and are sold at a high price to the barrel-forgers. Formerly the best gun barrels were made in Spain; and their superiority was attributed to the excellency of the iron made use of, which consisted almost exclusively of stub-nails, and the old shoes of the horses and mules: but the barrels now made in this country are not inferior to those of any country in the world. The method of making the barrel is this: The iron is first formed into a thin flexible bar, something like a cooper's hoop, and when heated is plied or twisted round a mandril, much in the same manner as a ribbon of leather is turned round the handle of a whip. The Damascus barrels, prized for their beauty, though inferior in strength, are composed of iron and steel in certain proportions laid crossways, and hammered together the whole length of the barrel. After the barrel has been forged, the inside is rendered smooth and perfectly cylindrical by boring. The exterior is smoothed by turning in a lathe.

By Act of Parliament every gun barrel offered for sale must be tried by a certain quantity of powder and weight of shot according to its size; but the best gunmakers do not trust to this legal test, and subject them to a severer trial by water-proof. For fowling-pieces and other guns of the best description the flint lock is now laid aside, and the percussion lock almost universally substituted.

The principles of the construction of guns or cannon have lately been the subject of the closest investigation. The main points to be attended to in the manufacture of a gun, whether smooth-bored or rifled, are: 1. The quality of the metal; 2. The form and length of the bore; 3. The exterior form of the gun, depending on the weight and distribution of the metal; 4. The preponderance and position of the trunnions. 1. The metal should be hard, elastic, and tenacious; no one of these properties must be sacrificed for the sake of the others. 2. The form of the bore is cylindrical, modified for rifled guns: and in all muzzle-loading guns a certain amount of windage is necessary, to allow of the shot being rammed home. The length of the bore should be such as to allow all the charge to be consumed before the shot leaves the gun, and to give the greatest initial velocity to the shot consistent with such lightness as is essential in order to work the guns. The lengths of guns in our service vary from about twelve to twenty calibres; all smooth-bored field guns being seventeen calibres long. 3. The exterior form of the gun should be such as to distribute the metal so as best to resist the strain of the gas, which is greatest at the breech, diminishing gradually towards the muzzle. All guns of recent construction are built on this principle, though the details may vary. The quantity of metal varies with the nature of the projectile and charge, and the service for which the gun is intended. The larger the calibre of the gun, the greater will be the strain exerted on the piece, because while the weight of the ball increases as the cube of its diameter, and the mass of the charge increases as the cube of the diameter of the bore, the surface acted on by the strain only increases as the square of the calibre, supposing the density of the shot to remain constant, and the charge to continue to bear the same relation to the weight of the shot. Ignorance of this principle has led many to think that success in a small gun or rifle argues equal success in a large piece of ordnance. Guns were formerly much ornamented externally; this practice, which actually weakened the metal, while increasing the expense, has now been abandoned. 4. In our service, a certain preponderance on the breech side of the trunnions has hitherto been given, to keep the gun steady on its carriage; but the Americans have done away with this, and apparently wisely, as a gun without preponderance is much more easily worked.

Until quite recently all guns in our service were cast, either iron or bronze. Now all, with few exceptions, are built up of wrought iron, or of steel barrels, with wrought iron outside.

Guns may be divided into breech-loaders and muzzle-loaders, smooth-bored and rifled. The above principles apply equally to all. The accompanying figure of an ordinary smooth-bored gun explains the shape and names of the chief parts. The *cascable* is from F to A;



first reinforce A to B; *second reinforce* B to C; *chase* C to D; *muzzle* D to E; *cd* is called the *breech*; G the *trunnion*.

The peculiarities of construction consequent upon guns being rifled, and the different systems of rifling, are explained in the article RIFLED GUNS. For the history of their invention, see CANNON; and for their employment in war, ARTILLERY. A table of the guns most commonly in use in our service is given in the article ORDNANCE. For further information, the reader is referred to Major Owen's *Lectures on Artillery*; and *Ency. Brit.* art. 'Gunmaking.'

Gun Cotton (Fr. coton poudre, Ger. schiesswoll). A highly explosive and inflammable substance, discovered in 1846 by Professor Schönbein, of Basle. As at present manufactured for military purposes, it is obtained by impregnating cotton in the form of thread, which has been thoroughly cleansed and dried, with a mixture of three parts of the strongest sulphuric acid and one part of the strongest nitric acid. The cotton is steeped in this for about forty-eight hours, and then whirled round in a centrifugal machine to remove the superfluous moisture. It is then immersed in cold water, and washed in a running stream till no acid is perceptible to the taste; it is now partly dried, and boiled for a few minutes in a weak solution of carbonate of potassa, and again restored to the stream for from fourteen to eighteen days; after which it is washed by hand and thoroughly dried. In these operations it is necessary to insure: 1. That the cotton be quite dry and pure before it is impregnated with acid; 2. That every particle be well saturated with acid; 3. That all free and superfluous acid be removed. The appearance of the cotton is not changed, but it weighs about seventy-seven per cent. more after these operations.

The skeins are now ready to be made up for use; and by the method in which the cotton is arranged, its explosive power can be regulated. Cartridges for cannon, where ignition should be gradual, are made up by winding the cotton round hollow cones of wood; bursting charges for shells, match lines, &c., by weaving the cotton into a hollow cylinder; small-arm cartridges in the same way, with layers of paper between the webs; for mining charges a hollow twisted rope is used.

The peculiar advantages of gun cotton for military and engineering purposes are: 1. The comparative absence of smoke and residuum or 'fouling matter:' less heat is evolved also than by gunpowder; 2. One pound of gun cotton equals three pounds of gunpowder in propelling force, and, if the ranges are equal, the recoil of a gun fired with cotton is much less; 3. Though the explosion of gun cotton in open space has very little effect, its violence increases with confinement, so that while it may be used as match in the air, it possesses enormous power for blasting, mining, exploding shells, &c.; 4. While the manufacture of gunpowder is complicated and full of danger, that of gun cotton consists only of soaking and washing, and is free from risk.

The points which must be determined before gun cotton can come into universal use, are: whether its qualities are permanent under ordinary care, and whether heat or damp produce loss of strength or dangerous decomposition. These questions have yet to be decided. As far as is known, gun cotton will explode at a temperature of 277° Fahr. (gunpowder not till 600° Fahr.); it must, however, be ascertained whether the heat of tropical climates will injure its quality. It can be exploded by percussion if placed between iron and iron, but only the portion actually struck takes fire. Gun cotton will absorb very little damp, and returns to its normal state on being restored to a dry place, whereas gunpowder is destroyed by wet. This property is of great value, as gun cotton may be buried or drowned, and made again fit for use by drying.

Soon after the invention of gun cotton, the Austrian government appointed a committee on the subject, to one of whom, baron von Lenk, the present success of the material is due. Some accidents, said to be owing to spontaneous explosion, caused its use to be discontinued in Austria. In England, in 1847, Messrs. Hall, of Faversham, commenced to make it; but an explosion caused the manufacture to be abandoned. Baron von Lenk's improvements having attracted notice, our government appointed a committee, which is now carrying on a series of elaborate experiments.

The chemical changes which take place in the cotton under the treatment above described, are not yet thoroughly understood; but it appears that in the gun cotton manufactured by Lenk and by Professor Abel at Waltham Abbey, three equivalents of hydrogen are replaced by hyponitric acid, the result being the formation of a material called *trinitro-cellulose*, and described by the formula $C_{36}\,H_{21}\,O_{30}, NO_4$. For further details respecting the manufacture and uses of gun cotton, see PYROXILINE.

Gun Pendulum. In Gunnery, a rest for a gun, suspended on an axis so as to form a pendulum. When the gun is fired, this pendulum recoils through an arc which is measured, and so the velocity of the shot can be calculated. [BALLISTIC PENDULUM.]

Gun Tackle. A system of pulleys, consisting of two single blocks, one movable, the other fixed, the standing end of the fall being made fast to the movable block. It increases the power threefold.

Gun-room. In ships of war which have no ward-room, the gun-room is the common dining and dwelling cabin of all officers except the captain and midshipmen. In ships with a ward-room, the gun-room is inhabited by the junior officers only.

Gunboat. A small vessel carrying not more than four guns, most frequently only one, and of trifling draught of water. Steam gunboats, especially when iron plated, are most powerful auxiliaries to a fleet; their light draught enables them to approach the shore or ascend rivers; their heavy guns tell with deadly effect from their near positions; while

they themselves, from their diminutive size, can scarcely be hit.

Bombvessels differ from gunboats in being of greater beam or width to withstand the vertical recoil of the mortars which they carry. They are rarely propelled by steam.

Gunner. In the Artillery, corresponds to private in the Line. The appointment of *master gunner* is an ancient office under the crown; it is found in the time of Henry VIII. It is now filled by pensioned sergeants of artillery.

GUNNER. In the Navy, a warrant officer responsible for the safety of the powder magazine, and the proper care of the great guns.

Gunnery. A science which has for its object to ascertain the effects produced by firing a projectile from a piece of ordnance, under every variety of circumstances; and thus to determine the right form of gun and projectile, the best proportion of charge, the elevation to be given to the piece, and the quality and disposition of material best adapted to resist the action of projectiles at various ranges.

Before any experiments can be carried on to ascertain how various causes affect the flight of a projectile, its initial velocity, or the velocity which it has on leaving the muzzle of the gun, must be determined. This has been effected by various methods. The ballistic and gun pendulums [BALLISTIC PENDULUM; GUN PENDULUM] were until lately employed; but the more accurate results obtained by Major Navez' instrument [ELECTRO-BALLISTIC APPARATUS] have caused its adoption for this purpose. Experiments of the greatest value were carried on by Dr. Hutton, in the latter half of the eighteenth century, 1783–5, and are to be found in his *Tracts*. From these experiments he deduced the following practical conclusions, which later investigations have tended to confirm:—

1. The velocities generated by the action of different charges of powder, in the same gun, are nearly as the square roots of these charges.

2. The velocities generated by the same charge of powder from the same gun upon balls of different densities, will be inversely as the square roots of the weights.

3. The velocities generated by different charges of powder upon balls of different densities will be nearly in the ratio of the square roots of the charges, divided by the square roots of the weights of the balls.

4. The velocity of the ball increases with the charge to a certain point, which is peculiar to each gun, where it is greatest; and by further increasing the charge, the velocity gradually diminishes till the bore is quite full of powder.

5. The velocity continually increases as the gun is longer, though the increase of velocity is very small in respect of the increase in length, the velocities being in a ratio somewhat less than that of the square roots of the length of the bore, but somewhat greater than that of the cube roots of the length, and indeed nearly in the middle of the ratio between the two.

6. The range increases in a much less ratio than the velocity, and is nearly as the square root of the velocity, the gun and elevation being the same. Very little is gained in the range by a great increase in the length of the gun, the charge being the same; for the range is nearly as the fifth root of the length of the bore, an increase so small as to amount only to about one seventh part more range for a double length of gun.

7. The time of the ball's flight is nearly as the range, the gun and elevation being the same.

8. A great difference in the velocity arises from a small degree of windage.

The following table of initial velocities of a few service projectiles is deduced from experiments with Navez' electro-ballistic apparatus:

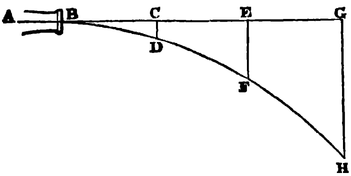
Nature of Ordnance		Charge	Projectile		Initial Velocity
			Nature	Weight	
		lb.		lb. oz.	Feet per second
Cast iron	10″ gun, 87 cwt.	12	Hollow shot	88 5	1,292
	68-pr. gun, 95 cwt.	16	Naval shell	51 8	1,809
	32-pr. gun, 58 cwt.	10	Solid shot	31 6	1,690
Bronze	12-pr. gun	4	" "	12 10¼	1,769
	9-pr. gun	2¼	" "	9 5¾	1,613
	6-pr. gun	1½	" "	6 3¾	1,484
Cast-iron 13-inch mortar		7	Mortar shell	204 8	506
Built-up iron	150-pr. gun, 12 tons	40	Solid shot	149 14	1,726
	" "	30	" "	" "	1,569
	" "	20	" "	" "	1,344
	100-pr. gun, 125 cwt.	25	" "	102 0	1,653
	7-inch gun	12	Common shell	103 14	1,166
	40-pr. L.S.	5	Solid shot	41 8	1,164
	20-pr. L.S.	2½	" "	21 3	1,114
	20-pr. N.S.	2½	" "	"	997
	12-pr.	1½	Segment shell	11 12	1,218
	9-pr.	1⅛	" "	9 6	1,036

The empirical formula used in our service for estimating the initial velocity of a projectile is

$$v = 1600\sqrt{\frac{ac}{w}},$$

where a = coefficient of windage (determined by experiment), c = the charge in lb., w = the weight in lb.

Knowing the initial velocity of a projectile, we can proceed to ascertain its velocity at any point of its flight, its trajectory, and its range; and for the sake of simplicity, we will first suppose its motion in a vacuum, where it is acted upon by two forces only, viz. the force of projection and the force of gravity. Suppose



a shot to be fired from a gun A B, in the direction A B C; if it were acted upon by the force of projection alone, it would continue to move in that direction with uniform velocity. But, the instant that the shot leaves the muzzle, it commences to fall by reason of gravity; and it falls in the first second of its flight sixteen feet, so that at the end of that time it has reached a point D, found by constructing a parallelogram, the sides of which represent the forces of projection and gravity respectively; and because the spaces through which a body falls by gravity are as the squares of the times, at the end of two seconds it has reached a point F, E F being equal to twice C D, at the end of three seconds a point H, G H being equal to three times C D, and so on, describing a parabolic curve B D F H. The properties of this curve being known, the trajectory, time of flight, &c., of a projectile fired in vacuo can be easily calculated, if the initial velocity is known; and since, as will be presently shown, the resistance of the atmosphere to a projectile fired with a very low initial velocity is very small, it may be practically disregarded for shells fired from mortars, and in that case the parabolic theory is found to give tolerably accurate results.

But the projectile fired under ordinary conditions from a gun, is acted upon by a third force, viz. the resistance of the atmosphere; and this so modifies the curve as to render the parabolic theory practically useless when a projectile is fired with a high velocity. Dr. Hutton's experiments showed that this resistance increases gradually up to a velocity of about 1,500 feet per second, when its ratio is to the velocity as the 2 153 power of the latter; but when the velocity exceeds this, the ratio again diminishes. Practically, however, for ordinary purposes of calculation, we may assume the resistance of the atmosphere to vary as the square of the velocity.

The nature of this resistance is explained by Dr. Hutton in his seventh tract. He considers that it 'is of a triple nature; one part of it being in consequence of the vis inertiæ of the particles of air, which the ball strikes in its course; another part from the accumulation of the elastic air before the ball; and the third part from the continued pressure of the air on the fore part of the ball, when the velocity of this is such as to leave a vacuum behind it in its flight, either wholly or in part.' Tables of resistances to a two-inch ball, derived from experiment, were constructed by Dr. Hutton.

The resistance which a projectile meets in moving through the atmosphere depends not only on its velocity, but on the magnitude of the surface it presents to the resistance, and its peculiar form. With spherical shot, the resistance will be as the squares of the diameters, and, as already shown, as the squares of the velocities, or as $d^2 v^2$.

But the *retardation* of a projectile, or its loss of velocity in consequence of this resistance, must not be confounded with the resistance itself. This retardation, while it is as the resistance, is inversely as the weight of a projectile. With a spherical shot, therefore, the weight being proportional to the cube of the diameter, the retardation will be as

$$\frac{d^2 v^2}{d^3};$$

consequently the greater the diameter of the ball, the less the retardation, where the initial velocities are equal.

If an elongated projectile and a ball of equal weight be fired with the same initial velocity, the former will be less retarded than the latter, because its diameter is less than that of the ball. Hence the more an elongated projectile is lengthened without altering its weight, the less will it be retarded, because its diameter will be reduced; and it is because elongated projectiles offer so much less resistance to the air than round shot of the same weight that their velocities are retained so much longer, and consequently that their range is so much increased.

The following comparison, deduced from actual practice, will show to how great an extent this is the case:—

Projectile	Range	Time of Flight	Initial Velocity	Mean Velocity	Final Velocity
	yds.	seconds	ft. per second	ft. per second	ft. per second
40-lb. segment shell (elongated) . .	2000	6·25	1164	960	756
68-lb. solid shot (ball)	2000	6·25	1579	960	341

The form of projectile which experiences the least resistance from the atmosphere has been the subject of many experiments, and it appears indisputably established that the shape of the hinder part is of some importance. The ogival form of head is probably the best. [PROJECTILE.]

The *final* or *remaining* velocity of a projectile is its velocity at any given point of its range; and varies, of course, with its retardation. Dr. Hutton established formulæ by which this might be calculated for spherical shot, and General Didion of the French army has established a formula equally applicable to elongated shot. Lieut. Noble, R.A., has lately constructed tables applying these formulæ to the Armstrong service shot. The following table will show some velocities of Armstrong service shot, at a range of 1,000 yards, determined by the electro-ballistic apparatus:—

	Gun	Charge	Projectile	Velocities at 40 yds.	Velocities at 1000 yds.	Velocity lost in 900 yards
		lb.				
Rifled B.L.	7-inch	12	111	1113	971	141
	7-inch	12	104	1144	997	147
	40-pr.	5	41½	1199	1013	185
	20-pr.	2½	20½	1153	976	176
	12-pr.	1½	11¾	1241	986	255

The penetration of a projectile depends to a great extent upon its velocity at the moment of impact, its weight and form, the material of which it is made, &c. At the moment of impact there is stored up in the projectile an amount of accumulated work, which causes to vibrate, penetrates, or fractures, the object struck; and which also tends to destroy the projectile. The penetration, however, must not be confounded with the work or momentum. A battering ram and a shot may have equal momentum; the shot will penetrate a wall, doing little damage beyond its own immediate vicinity; the ram will cause a large portion of the wall to vibrate, without penetrating. If two projectiles of the same form be fired with equal initial velocities at the same range into the same resisting material, their penetrations are as their diameters and densities, and the squares of their velocities; thus, the greater the diameter and density, the greater will be the penetration. When shot of the same density are fired into the same material, their penetrations vary as their diameters and the squares of their velocities.

From this it is evident that great velocity is the most necessary element of penetration, and that the American plan of firing heavy shot with low velocities is not good for penetration: for instance, if two spherical shot strike an object, one of ten inches diameter with a velocity of 1,200 feet per second, the other of six inches diameter with a velocity of 1,600 feet per second, the penetration of the larger shot to the smaller will be as $10 \times 1{,}200 \times 1{,}200 : 6 \times 1{,}600 \times 1{,}600$; or as $14{\cdot}4 : 17{\cdot}9$.

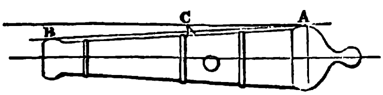
For the form and material of projectile best adapted for penetrating purposes, see PROJECTILE.

The following table of penetrations will show what was done at Eastbourne against a martello tower, best brickwork, range 1,032 yards:—

Elongated (Armstrong): Nature of Projectile	Weight	Charge	Penetration	Spherical: Nature of Projectile	Weight	Charge	Penetration
	lb.	lb.	ft. in.		lb.	lb.	ft. in.
7-inch shell . .	100	9	3 8	68-pr. shot . .	68	16	1 8
6-inch shot . .	82	10	7 6	68-pr. shell . .	51	16	1 9
6-inch shell . .	77	9	4 3	32-pr. shot . .	32	10	1 4
40-pr. shot . } 40-pr. shell . }	41	5	4 1	32-pr. shell . .	23½	10	1 4

The application of gunnery depends upon the above principles, and on others which cannot be noticed within the limits of this article. It is evident that in order to cause a shot to strike an object at a distance, the axis of the gun must be directed upon a point above the object aimed at, but in the same vertical plane. The charges for various guns being determined, experiments have shown the various elevations necessary to obtain various ranges, and tables have been constructed from these. In order to *lay* a gun correctly, the gun is provided with sights.

A line A B drawn from the highest point of the base ring A to the highest point of the



muzzle B (when the trunnions are horizontal), is called the *line of metal*, and notches are cut in the gun at those two points. Now if the line of metal be directed to the object, that line will necessarily be in the same vertical plane with the object; but by reason of the conical shape of the gun, the line of metal has an inclination to the axis, and consequently if these two points are brought into line with the object, the axis of the gun will point above it. This inclination of the line of metal to the axis of the bore is called the *line of metal elevation*, and varies from 1° in light field guns, to 2¼° in Monk's guns.

To allow the gun to be laid *point blank*, and at elevations less than the line of metal elevation, a *dispart sight* C is placed on the gun, the head of which forms with the notch on the base ring a line A C, parallel to the axis of the bore; so if these two sights are directed on an object, the axis of the gun is also pointed at it, but some few inches below. Now, this dispart sight being fixed, a tangent scale, of which the

head is made (when down) to correspond with the notch in the base ring, is attached to the gun at the breech, and can be raised and fixed at any required height. It is graduated with degrees corresponding to the radius from the head of the dispart sight, so that if it be necessary to give a gun 3°, or any other required amount of elevation, it is only necessary to raise the tangent scale to that amount, when the line of sight will be inclined at the required angle to the axis of the bore. This method of sighting is adopted with various modifications for all kinds of guns.

Although of late years much attention has been directed to the problems of gunnery, the great expense attendant upon practical experiments forbids private investigation. A systematic course of experiments is very much required, in which the one object should be to determine certain laws, which as yet are but imperfectly defined.

See ARTILLERY; CANNON; GUN; ORDNANCE; PROJECTILE; RIFLED ARMS; and the following, which are among the chief works on Gunnery: Robin's *Mathematical Tracts*; Hutton's *Tracts*; Sir Howard Douglas' *Naval Gunnery*; Boxer's *Treatise on Artillery*; Owen's *Lectures on Artillery*, from which the tables in this article are taken by permission; Paixhaus' *Force et Faiblesse de la France*; Didion's *Traité de Ballistique*; Piobert's *Traité d'Artillerie* and *Cours d'Artillerie*.

Gunney (Bengal.). A coarse sackcloth made in Bengal of the fibres of two species of *corchoron*. Rice, saltpetre, pepper, and other articles exported from Calcutta are packed in bags or sacks made of this material; they also form a considerable article of exportation.

Gunpowder. An intimate mixture of saltpetre, sulphur, and charcoal, the proportions in the powder made for the English government being about 75 parts saltpetre, 10 sulphur, 15 charcoal. The ingredients, which should be quite pure, are weighed out, pulverised, mixed, incorporated under rollers, pressed (50 to 70 tons on the square foot), granulated, dusted, glazed by friction, dried, and the powder thus made is packed in barrels.

The value of gunpowder consists in its containing stored up in small space substances which, on the temperature of the least portion of them being raised to about 700° Fahr., suddenly expand with great force, developing at the same time so much heat as to augment in a high degree the elasticity of the gases produced. Gunpowder is easily manufactured, has no tendency to spontaneous combustion, does not absorb moisture readily, and by the alteration of the size of the grains, and of the pressure to which it is subjected in manufacture, can be made to develope its force in greater or less time as may be required.

The absolute force of gunpowder has never yet been accurately determined; but as much attention has been given lately to the subject, and the means of obtaining accurate results from experiments are increasing, we may hope soon to have the point settled. The principal gases evolved on combustion have hitherto been supposed to be carbonic acid, carbonic oxide, nitrogen, &c.; but even this point has been much contested; and it has been lately shown by M. Melsus that at a very high temperature two volumes of carbonic acid may become three volumes of carbonic oxide and oxygen, similar changes taking place in the other products.

The history of the invention of gunpowder is involved in obscurity, and must remain so until some contemporary voucher can be produced. It was not used in Europe as an agent in warfare, till about 1320–1330. [CANNON.]

Gunpowder Plot. In English History, the celebrated conspiracy of certain disappointed Roman Catholics to destroy the king, James I., and the two houses of parliament, by gunpowder, which was detected on the fourth of November, 1605. The story which affirms that by extraordinary sagacity King James detected the nature of the plot from the mysterious letter sent to Lord Monteagle, seems now to have lost all credit. It had long been remarked that Salisbury and Carlisle (probably before the scheme between themselves and their royal master was concerted) had claimed for *themselves* the credit of the discovery; and it now appears that Lord Monteagle had been previously rewarded by government for mysterious services, apparently rendered in the capacity of spy: so that it is highly probable that he was acquainted with the design of the malcontents, and that the celebrated letter was an invention, destined to conceal the real mode of discovery. Those who are anxious to study the Roman Catholic version of the story will find it ably detailed in the pages of Lingard (vol. vii. ch. 1. 4to ed.). That writer seeks to throw the whole onus of the conspiracy on Catesby, its chief promoter, and to exculpate Father Garnet; Mr. Jardine (in his *State Trials*) is of a different opinion.

Gunter's Chain. The chain commonly used for measuring land. It is 66 feet or 4 poles in length, and consists of 100 links, each of which is joined to the adjacent one by three rings; the length of each link, including the connecting rings, is 7·92 inches. The advantage of this measure consists in the facility which it affords for numerical calculations. The English acre contains 4,840 square yards, and Gunter's chain being 22 yards in length, the square of which is 484, it follows that a square chain is exactly the tenth part of an acre. A square chain, again, contains 10,000 square links, so that 100,000 square links are equal to an acre; consequently the area of a field being estimated in square links, it is only necessary to divide the result by 100,000, or to cut off the last five figures, to obtain the

Gunter's Line. A logarithmic line engraved on scales, sectors, &c., serving to perform the multiplication and division of numbers instrumentally, as a table of logarithms does arith-

metically. The numbers are usually drawn on two separate rulers sliding against each other. In rough calculations this line affords considerable facilities.

Gunter's Quadrant. A quadrant of a peculiar kind adapted to the problems of finding the hour of the day, the sun's azimuth, and other common problems of the sphere.

Gunter's Scale. A large plane scale having various lines of numbers engraved on it, by means of which questions in navigation are resolved with the aid of a pair of compasses. It is usually called the *Gunter* by seamen. On one side of the scale the natural lines (as the line of chords, the line of sines, tangents, rhombs, &c.) are placed, on the other the corresponding logarithmic ones.

Gunwale. Means, generally, the upper part of the side of a vessel or boat.

Gurgoyle (Fr. gargouille, *a water-shoot*). In Gothic Architecture, the water from the roofs of buildings was commonly made to pass through the mouth of figures shaped like animals. These figures were sometimes ingeniously employed during the middle ages as vehicles for satire; and, like the carvings under the seats of stalls, illustrate the feuds of the secular and regular clergy, &c. They also served as images of evil spirits, put to base uses outside the church.

Gurhofite. A compact magnesian carbonate of lime, from Gurhoff in Lower Austria.

Gurnard or **Gurnet.** [Trigla.]

Gutta Percha. This important article, the uses of which in arts and manufactures are rapidly increasing, is the produce of a large forest tree (*Isonandra Gutta*, Nat. Ord. *Sapotaceæ*) growing in the mountains of Singapore, and in the forests of Johore at the extremity of the Malayan Peninsula, and in Borneo; it is plentiful at Sarawak, where it is called *Niato*; it is also supposed to abound on the clusters of islands to the south of Singapore. The gutta percha appears to separate from the juice or sap of the tree in the same way as India-rubber, and its general properties in regard to solvents and to the products of destructive distillation resemble those of caoutchouc. At common temperature gutta percha is somewhat hard and very tough and unyielding; but when immersed in boiling water it softens so as to admit of being beaten into a mass and moulded into any requisite shape, and on cooling it resumes its hardness. In very thin films it has a pale yellow or pinkish tinge, but generally occurs in brown or blackish lumps or masses, of a somewhat mottled appearance upon the cut surface, and translucent at the edges. When softened it may be stretched into slips which do not recover their former shape when the force is withdrawn, but retain a kind of leathery pliability on cooling. When heated to about 350° gutta percha undergoes a kind of fusion, and remains viscid when cold. It burns with a yellow smoky flame. It is said to be obtainable in very large quantities, but that from the destructive mode hitherto pursued by the natives in obtaining it, there is a risk of its scarcity. It was first made known in England in 1843 by a communication from Dr. Montgomery to the Society of Arts.

Gutta percha has been applied to the manufacture of cements, architectural and other ornaments, bookbinding, tubes, water-pipes, engine-hose, picture-frames, bottles, and drinking cups, and to the soles of boots and shoes, &c. &c. When blended with caoutchouc, it is used for a variety of other purposes. It becomes highly electrical by friction.

Gutta Serena (Lat.). [Amaurosis.]

Guttæ. In Architecture. [Drops.]

Guttiferæ (Lat. gutta, *a drop*, and fero, *I bear*). A natural order of hypogynous Exogens, typical of the Guttiferal alliance, and often called *Clusiaceæ.* In that alliance they are distinguished by their simple opposite leaves, without stipules, their symmetrical flowers with equal-sided petals and adnate beakless anthers, their sessile radiating stigmas, and their solitary or few seeds. Lindley associates them with *Hypericaceæ* and *Ternströmiaceæ.* The order contains some plants of great utility.

Guttur (Lat. *a throat*). In Mammalogy, is applied to the whole under surface of the neck.

Gutturals (Lat. guttur). Letters pronounced by a peculiar effort of the throat. There are no gutturals properly so called in the English language, although the guttural sound may often be heard in some provincial pronunciations of the letter *r*. Nor are there in the pure French or Italian, although they are frequent in the dialects: e. g. the letter *c* hard (as in *casa*) has in the Tuscan a strong guttural sound. In the Spanish language alone, of those derived from the Latin, gutturals are common. In German, the guttural *ch* is largely used. In the Celtic languages, *gh* and *ch* are also sounded with much variety of guttural intonation.

Guy. A rope used to swing any weight, or to keep steady any heavy body and prevent it from swinging while being hoisted or lowered; also the tackle by which any fore-and-aft sail is held forward to prevent it gybing.

Gybing. In Sailing, the act of going about when the wind is astern or abaft the beam. It consists in bringing the ship's head across the wind, when the wind exercises its force on the opposite side of the sail to that which it previously affected.

Gyle. A large vat or cistern. The *liquor-gyle* in a brewery is the water-cistern or vat.

Gymnasiarch (Gr. γυμνασίαρχος). An officer who had the charge of the gymnasia and of all matters relating to them. This was one of the offices which at Athens were called Liturgies [which see].

Gymnasium (Lat.; Gr. γυμνάσιον). Originally a space measured out and covered with sand for the exercise of athletic games. Afterwards, among the Greeks, the gymnasia became spacious buildings or institutions for the mental as well as corporeal instruction of youth. They

were first built at Lacedæmon, whence they spread through the rest of Greece, &c. into Italy. They did not consist of single edifices, but comprised several buildings and porticoes, used for study and discourse, for baths, anointing rooms, palæstras in which the exercises took place, and for other purposes. Two of the Athenian gymnasia, viz. the Lyceum and Academy, were rendered famous by being the scenes of the lectures of Aristotle and Plato respectively.

The term *gymnasium* has descended to modern times. In Germany the higher schools, intended to give immediate preparation for the universities, are termed *gymnasia*. In Prussia the scholars undergo examination on leaving them: their compositions at this examination are sent to the minister of instruction and ecclesiastical affairs; and they receive testimonials of fitness, No. 1, No. 2, or No. 3, according to their degree of proficiency. Persons who have fitted themselves for the universities without passing through the gymnasia are examined by a committee appointed by government, which sits half-yearly for the purpose.

Gymnastics (Gr. γυμναστικός). Under this name were comprised by the ancients all those games and exercises which were performed with the body partly naked (γυμνός); such as wrestling, boxing, running, throwing the quoit, playing at ball, &c. They were first instituted at Lacedæmon, where they were not confined to men, but were also considered a necessary part of the education of females. In the rest of Greece, where they subsequently spread, they were also held of the highest importance, and as such were conducted under the superintendence of the government, and entered conspicuously into the political schemes of the philosophers. In this respect the Greeks offered a remarkable contrast to their Asiatic neighbours, among whom it was considered a great disgrace even for a man to be seen naked. At Rome gymnastics were principally exercised by the mercenary athletes.

Gymnodontes (Gr. γυμνός, *naked*; ὀδούς, *a tooth*). The name of the family of Plectognathic fishes comprehending those which have the jaws protruding, and covered with a more or less complex layer of dense ivory substance serving the office of teeth.

Gymnogens. A name proposed by Lindley for the naked-seeded plants referred to the orders *Coniferæ*, *Taxaceæ*, *Gnetaceæ*, and *Cycadaceæ*. In these plants there is no proper ovary, but the seeds are fertilised by the pollen coming in direct contact with the foramen of the ovule. They are also called *Gymnosperms*; that is, literally, naked-seeded plants. Gymnogens are largely represented amongst fossils.

Gymnosophists (Gr. γυμνοσόφισται, *naked philosophers*). A sect of Indian philosophers who lived naked in the woods, and submitted to other strange austerities. They believed in the immortality and transmigration of the soul, and enjoyed great reputation for astronomical and physical science.

There was likewise an African sect of philosophers bearing the same name, who are said to have lived in Æthiopia, near the sources of the Nile, whose habits differed from those of the Indian sect, inasmuch as they lived as anchorites, while the latter congregated in societies.

Gymnospermia (Gr. γυμνός, and σπέρμα, *a seed*). An order of the Linnæan class *Didynamia*, in which the fruit consists of a few nut-like carpels surrounded by the calyx, instead of being enclosed in a capsule, as in the rest of the order. The *Labiatæ* are illustrations, but such seeds are not strictly naked.

Gymnotus, or rather **Gymnonotus** (a word coined from Gr. γυμνός, *naked*, and νῶτος, *the back*). The name of the genus of electric eels which are found in the fresh waters of South America: they have a median fin extended along the belly, but none on the back. Although to all outward appearance the gymnotus is nearly allied to the eel, yet, were that part of the body cut off which contains the nutrient, respiratory, and generative organs—all the parts, in fact, which are essential to the existence of the gymnotus as a mere fish—it would present a short and thick-bodied form, very different from that of the eel. The long electric organs are tacked on, as it were, behind the true fish, and thus give the gymnotus its anguilliform body. The backbone and muscles are of course coextended with the electric organs for their support and motion; and the air-bladder is continued along the produced electrophorous trunk, to give it convenient specific levity. Two long dorsal nerves are continued from the fifth and eighth cerebral nerves for ordinary sensation and motion. The spinal chord is continued along the vertebral column, for the exclusive supply of the electrical organs. These organs are four in number; two very large above, and two small ones below. The electricity discharged from them decomposes chemical compounds, produces the spark, and magnetises iron, as does that of the torpedo. But the magnetising power seems to be relatively weaker, while the benumbing shock communicated to other animals is stronger than in any other electric fish.

Gyn. In Artillery, a machine for mounting and dismounting ordnance from their carriages, &c. There are triangle and Gibraltar gyns in our service. [DERRICK.]

Gyn Tackle. A system of pulleys consisting of a double and triple block, the standing end of the fall being made fast to the double block, which is movable. It increases the power fivefold.

Gynæceum (Gr. γυναικεῖον). In ancient Greek Architecture, the portion of a dwelling or a public building set apart for the occupation, or for the exclusive use, of the female sex.

GYNÆCEUM. In Botany, a term invented by Rœper to denote that organ commonly called the *pistil*: it may be understood to signify the female apparatus in plants.

Gynæcocracy (Gr. γυναικοκρατία). A term sometimes used to indicate that state in which women are legally permitted to assume

the reins of government. It is used by way of contradistinction to the *Salic law*, which precludes them from the privilege of sovereignty. There are only five states in Europe to which the operation of the Salic law does not extend—England, Russia, Spain, Portugal, and Denmark.

Gynæconomi or **Gynæcocosmi** (Gr. γυναικονόμοι, γυναικοκόσμοι). Athenian officers, who seem to have acted as a sort of police in repressing excesses whether committed by men or women. But the time of their institution and the precise nature of their duties are not clearly ascertained.

Gynandria (Gr. γυνή, and ἀνήρ, *a male*). The name of one of the classes in the sexual system of Linnæus. Its character is to have the stamens, style, and stigma consolidated into a body, called a *column*. The class chiefly consists of the plants now named *Orchidaceous*.

Gynandrous. In Botany, plants of which the structure is referred to the Linnæan class *Gynandria*; i.e. which have the stamens, style, and stigma consolidated into one common body, called the *column*.

Gynobase (Gr. γυνή, and βάσις, *a base*). In Botany, the growing point inserted between the base of carpels in a conical manner, so as to throw them into oblique position. Such carpels are *gynobasic*; they have basilar styles which are enlarged and cohere in the centre. The Borage is an example of this structure.

Gynophore (Gr. γυνή, and φέρω, *I bear*). In Botany, the stalk sometimes developed at the base of the ovary within the calyx, as in the Passion-flower and the Caper-tree.

Gynostemium (Gr. γυνή, and στήμων, *a stamen*). A term invented by Richard to denote the column of an Orchidaceous plant. It is a combination of a filament and a style.

Gypogeranus (Gr. γύψ, *a vulture*, and γέρανος, *a crane*). The name was invented by Illiger for a most singular genus of Accipitrine birds, in which the structure of the bird of prey is modified by a lengthening of the legs and neck to adapt the species to combat with and destroy the most poisonous of the serpent tribe. The instincts of the gypogeranus, or secretary bird, as it is termed, correspond with its structure, and it preys principally on serpents; not refusing, however, lizards, or even insects. The bill is shorter than the head, curved nearly from its base, not toothed; the wings are armed with a short, strong, and obtuse spur; the feathers are continued down the long tibia to the tarsal joint, covering the front but not the back part of it; the toes are short, but strong; the anterior ones united by a membrane at the base. Species of the secretary vulture inhabit the Cape, the Gambia coast, and the Philippine Islands. The Cape secretary (*Gypogeranus serpentarius*) lives in pairs, builds on high trees, and runs with considerable swiftness.

Gypsies. The history of this strange nation of vagrants has been illustrated by the labours of several German writers, particularly Grellman (*Historical Inquiry respecting the Gypsies*, translated into English by Raper, 1787) and Bischoff (*German and Gypsy Dictionary*). Their English name is said to be a corruption of the word *Egyptian*: the French call them Bohemians; but the names by which they are most widely known throughout Europe are, the German *Zigeuner*, Russian *Tzigan*, Italian *Zingaro*, Spanish *Gitano*, Turkish *Chinganeh*—all apparently varieties of the same distinctive appellation. Their origin has long been a subject of curious but unsuccessful antiquarian research. In Western Europe, they made their first appearance early in the fifteenth century, under a leader who styled himself the Duke of Lower Egypt: fortune-telling and thieving were then, as now, their predominant occupations. They were at that time treated as heathens and sorcerers, and the most severe laws were repeatedly enacted against them. At present they are found not in Europe only, but in Asia Minor, Egypt, Turkey, &c., forming everywhere a distinct race. In Germany, as well as England, they profess various trades, as itinerant horsedealers, smiths, farriers, &c.; but they have never been reclaimed in any number to settled occupations. In England their most ordinary haunts are in the midland and southern counties, whither they are invited by the abundance of green lanes, downs, forests, or chases. They possess a language of their own; and are apparently destitute of religion, although in most countries professing that of the people among whom they dwell. (Marsden *On the Language of the Gypsies*; Hoyland's *Hist. Survey*, 1816; *Quart. Rev.* vol. lv.; Borrow's *Account of the Gypsies of Spain*.)

The ancient severe statutes against these people have been repealed, and they are now only punishable as vagrants by the 5 Geo. IV. c. 83 s. 4, amended by 1 & 2 Vict. c. 38.

Gypsum. This is one of the many synonyms of native *sulphate of lime*. The varieties of it will be found described under their respective names, such as *Selenite*, *Satin Spar*, and *Alabaster*. As a *rock*, it is less common than most other substances that form distinct rock-masses, and is generally associated with marls and with rock-salt. It is sometimes applied as a top-dressing to clover and leguminous crops, but has lately fallen into disuse.

Gyrate (Lat. gyratus). In Botany, a term applied to bodies which are curled inwards like a crozier, as the young undeveloped fronds of Ferns.

Gyration (Lat. gyrus, Gr. γῦρος, *a circle*). In Mechanics, this term is synonymous with *rotation*. In combination with other words, however, the term gives rise to several technical expressions which require a brief explanation. A *centre of gyration* is a point within a body such that if the whole mass were concentrated therein, the moment of inertia with respect to the corresponding *axis of gyration* would remain unaltered. The circle described by such a point is called a *circle of gyration*, its radius the *radius of gyration*. Calling the latter x and denoting by dm the

mass of any element at the distance r from the axis, then M being the total mass of the body equal to $\int dm$, we have $Mx^2=\int r^2dm$, where the integration is to be extended to all points of the body. The *principal radii of gyration* of a body with respect to any point are the radii of gyration with reference to the three principal axes through that point. An ellipsoid whose axes coincide in direction with those of the principal axes, and in magnitude with the corresponding radii of gyration, is called the *ellipsoid of gyration.*

Gyration, Ellipsoid of. [INERTIA, MOMENT OF; PRINCIPAL AXES.]

Gyrencephala (Gr. γῦρος, and ἐγκέφαλος, *brain*). A sub-class of *Mammalia*, consisting of those orders in which the superficies of the cerebrum is folded into gyri or convolutions, while the hinder lobes project over more or less of the cerebellum, and the olfactory lobes are covered. Those traces of affinity to the Oviparous sub-kingdom which the *Lyencephala* and *Lissencephala* present are absent in these animals. With the exception of the Elephants, the blood from the head and anterior limbs is returned to the right auricle by a single precaval trunk. The orders *Quadrumana, Carnivora, Artiodactyla, Perissodactyla, Proboscidea, Toxodontia, Sirenia*, and *Cetacea*, belong to this sub-class. The mammalian modification of the vertebrate type attains its highest physical perfections in the *Gyrencephala* as manifested by the bulk of some, by the destructive mastery of others, by the address and agility of a third order; and through the superior psychological faculties which are associated with the higher developement of the brain, the *Gyrencephala* afford those species which have ever formed companions and servitors, and valuable sources of wealth and power, to mankind.

Gyrfalcon. [JERFALCON.]

Gyri (Lat.; Gr. γῦρος). In Mammalogy, the annular series of scales in the tails of certain quadrupeds.

Gyrinus (Lat.; Gr. γύρινος, *a tadpole*). The water flea.

Gyrodus. A fossil fish of the family of *Pycnodonts*. It occurs in the oolite of Baden.

Gyrogonites (Gr. γῦρος, and γόνος, *seed*). Bodies found in fresh-water deposits; originally mistaken for small shells, but afterwards ascertained to be the seed-vessels of plants of the genus *Chara*.

Gyroscope (Gr. γῦρος, and σκοπέω, *I look*). An instrument for illustrating the composition and resolution of rotations. It consists essentially of a disc which rotates around the diameter of a ring which itself rotates around the diameter of a second ring.

Gyrose (Lat. gyrus, *a circle*). In Botany, a term applied to bodies which are bent backwards and forwards, like the anthers in Cucurbitaceous plants.

H

H. An aspirate of the guttural kind, used in most modern and ancient languages. The claims of *h* to be regarded as a letter have been denied by many grammarians; and certainly, when it is remembered that the sound of this letter is produced by a mere emission of the breath, without any conformation of the organs of speech, this opinion would seem well founded. There are others, however, who insist that there is no feature in the sound or qualities of this letter which it does not possess in common with some other consonants, and, consequently, any attempt to invalidate its claim to the distinction, militates equally against them. The figure H was used by the Greeks to signify the aspirate, until about the fifth century before Christ. After that time it was gradually abandoned in Greek writing, while its use was still preserved by the Latins. In the former language it was superseded by the small mark called the *spiritus asper* (ʽ), which was placed above the letter to which the aspirated sound was to be given. In many Latin words the letter *s* represents the Greek aspirate, as *sub* for ὑπό, *sal* for ἅλς, *sex* for ἕξ, *septem* for ἑπτά, *serpo* for ἕρπω, &c. As an abbreviation, *h* was used by the Latins for homo, hæres, and hora; and as a numeral it expressed 200.

H. In Music, the designation given by the Germans to the note B♮; their B being equivalent to the English B♭.

Habeas Corpus (Lat.). In Law, the title of a writ, of which there are several kinds. *Habeas corpus ad respondendum* is to remove a prisoner, confined by the process of an inferior court, in order to charge him with a new action in a court above. *Habeas corpus ad subjiciendum* is a high prerogative writ, directed to a person detaining another, and commanding him to produce the body of the prisoner. This is the writ which, by stat. 31 Ch. II. c. 2, must be granted on application of any party committed and charged with any crime except treason or felony; or, if charged with those crimes, having been acquitted or not tried on the second term or session after his commitment. It had been held that this writ issued from the superior courts in England to all the foreign dependencies of the crown; but by 25 & 26 Vict. c. 20 this power is abolished as to colonies having courts able to issue the writ.

Habere Facias Possessionem (Lat.). In Law, a judicial writ, sued out by the successful plaintiff in an action of ejectment, as a direction to the sheriff to cause him to have possession of the land and premises recovered; and this the sheriff is bound to execute, breaking open doors, or summoning the posse comitatus, if necessary.

Habergeon (Fr. haubergeon). A small short hauberk. [HAUBERK.]

Habzelia. The plants now referred to this genus of *Anonaceæ* were formerly placed in *Xylopia*, and are by many retained there. *H. æthiopica*, the Ethiopian Pepper, is a tall shrub, with egg-shaped leaves, downy beneath, and bearing pod-like carpels, which are dried and used instead of pepper. Other species possess similar pungent and aromatic properties.

Hack. A name given to the rows of crude bricks, as they are exposed in the field to dry.

Hackle. A board set with sharp iron spikes for combing or pulling out hemp.

Hackles. A term applied to the slender feathers, from the necks and backs of birds, used by fly-fishers. The most esteemed hackles are the *duns.*

Hackney Coaches (Fr. coche-a-haquenée, from haquenée, a horse formerly let out on hire for short journeys). Vehicles for hire were first introduced in France in 1650 [FIACRE]; in England a few years earlier, and in Edinburgh in 1673.

Haddock. This fish, *Morrhua Æglefinus*, is found in the Northern Ocean, but does not enter the Baltic. It makes its annual appearance on the Yorkshire coast in December, in a vast shoal extending from Flamborough Head to the mouth of the Tyne.

Hades (Gr. ᾅδης, also ἀΐδης). In Greek Mythology, a word denoting the abode of the dead, or the god of the nether world, called also Pluto. The origin of the name is doubtful. According to Hesiod, the mortals of the brazen age were the first who descended to Hades.

Hading. In Mining, the direction of a slip or *fault*. The deviation from the vertical of a mineral vein is called its *hade.*

Hadj (Arab.). The Mohammedan pilgrimage to Mecca and Medina: whence Hadji, a pilgrim, or one who has performed this pilgrimage; Hedjaz, the holy land, where these cities are situated. The most complete and authentic description of it is that of Burckhardt, who performed it, in the guise of a Mohammedan, in 1814. It is fixed to a particular lunar month, and consequently takes place in every season of the year. It was a custom long anterior to the establishment of Islamism, the famous 'black stone' of the Caaba at Mecca being then the object of veneration. Every year a black silk stuff is now sent by the sultan to cover the Caaba. There are usually five or six caravans; from Syria, Egypt, Barbary, the East, and the North. In 1814, the number of pilgrims was about 70,000, and this was considered small. The pilgrims go through several ceremonies at Mecca, of which the principal are the *tewaf*, or procession round the Caaba, and drinking of the well Zemzem; they then proceed to the summit of the hill Al Akaba; and lastly to Medina, the place of the prophet's burial. (Burckhardt's *Travels in Arabia*, 1829; *Quart. Rev.* vol. xlii.: see also the travels of Captain Burton, who succeeded in visiting the holy city in disguise.)

Hæmachrome (Gr. αἷμα, *blood*, and χρῶμα, *colour*). The colouring matter of the blood: called also *hæmatosyn.*

Hæmacrymes (Gr. αἷμα, and κρυμός, *cold*). A name by which Latreille designates the animals with cold blood.

Hæmal Arch (Gr. αἷμα). That part of the vertebra or primary segment of the skeleton which encompasses the main axis, or its prolongations, of the vascular system. It is situated opposite the neural arch, and, except in man, is inverted and beneath the centrum.

Hæmapophysis (Gr. αἷμα, and ἀπόφυσις, *process*). The autogenous vertebral elements which close or form the hæmal arch. In the human thorax they close the arch, as *cartilages of the ribs*, with the aid of a hæmal spine or sternal bone; in the Saurian tail they form, with the spine, the entire hæmal arch.

Hæmatemesis (Gr αἷμα, *blood*, and ἔμεσις, *vomiting*). Vomiting of blood from the stomach, generally preceded by weight and uneasiness about the region of the stomach, and unaccompanied by cough and the other symptoms of *hæmoptysis.*

Hæmatherms (Gr. αἷμα, and θέρμη, *heat*). The name given by Latreille to the animals with warm blood.

Hæmatics. Medicines presumed to act especially upon the composition of the blood.

Hæmatine (Gr. αἷμα). The colouring principle of Logwood.

Hæmatinics. Medicines which tend to increase the proportion of the colouring globules of the blood. Certain preparations of iron are supposed to belong especially to this class.

Hæmatite. Native oxide of iron: its streak and powder are blood-red. It occurs in Cumberland, where it is used in the manufacture of steel.

Hæmatocele (Gr. αἷμα, and κήλη, *a tumour*). A tumour arising from extravasated blood.

Hæmatocrya (Gr. αἷμα, *blood*; κρύος, *cold*). This class has been proposed by Professor Owen to include the groups of animals commonly termed *fishes* and *reptiles*. 'The conformity of pattern in the arrangement of the bones of the outwardly well-ossified skull in certain fishes with well-developed lung-like air-bladders, e.g. *Polypterus, Lepidosteus, Sturio*, and in the extinct reptiles *Archegosaurus* and *Labyrinthodon*; the persistence of the notochord (*chorda dorsalis*) in *Archegosaurus*, as in *Sturio*; the persistence of the notochord and bronchial arches in *Archegosaurus* and Lepidosiren; the absence of occipital condyle or condyles in *Archegosaurus*, as in Lepidosiren; the presence of teeth with the labyrinthine interblending of dental tissues in Dendrodus, Lepidosteus, and

Archegosaurus, as in Labyrinthodon; the large median and lateral throat-plates in Archegosaurus, as in Megalichthys, and in the modern fishes Arapaima and Lepidosteus; all these characters point to one great natural group, remarkable for the extensive gradations of developement linking and blending together piscine and reptilian characters within the limits of such group. The salamandroid (or so-called *sauroid* Ganoids, e.g. Lepidosteus and Polypterus, are the most ichthyoid, the Labyrinthodonts are the most sauroid, of this annectant group; the Lepidosiren and Archegosaurus are intermediate gradations, one having more of the piscine, the other more of the reptilian character. Archegosaurus conducts the march of developement from the fish proper to the labyrinthodont type; Lepidosiren conducts it to the perennibranchiate or modern batrachian type. Both forms expose the artificiality of the ordinary class distinction between Pisces and Reptilia, and illustrate the naturality of the wider class of cold-blooded vertebrates, which I have called Hæmatocrya. The correlative group of warm-blood animals is termed Hæmatotherma.' Professor Owen is 'unable to define any adequate boundary for dividing cold-blooded air-breathing vertebrates into two distinct classes of Batrachians and Reptiles,' and he is as little able to point out a character dividing the air-breathing from the water-breathing *Hæmatocrya*, the Reptiles from the Fishes. The following is the classification proposed:—

A. Subclass Reptilia.
- Order 1. *Batrachia.*
  - Fam.: Anoura, Urodela.
- Order 2. *Chelonia,*
  - Fam.: Terrestria, Paludinosa, Fluvialia, Marina.
- Order 3. *Ophidia.*
  - Fam.: Crotalidæ, Colubridæ, Hydrophidæ.
- Order 4. *Lacertilia.*
  - Fam.: Chamæleontidæ, Geckotidæ, Iguanidæ, Varanidæ, Teidæ, Lacertidæ, Chalcidæ, Scincidæ.
- Order 5. *Crocodilia.*
  - Fam.: Procœlia, Opisthocœlia, Amphicœlia.
- Order 6. *Dinosauria.*
  - Fam.: Herbivora, Carnivora.
- Order 7. *Thecodontia.*
- Order 8. *Pterosauria.*
- Order 9. *Anomodontia.*
  - Fam.: Dicynodontia, Cryptodontia, Cynodontia.
- Order 10. *Sauropterygia.*
  - Fam.: Plesiosauria, Simosauria.
- Order 11. *Ichthyopterygia.*
- Order 12. *Labyrinthodontia.*
- Order 13. *Ganocephala.*

B. Subclass Fishes.
- Order 14. *Plagiostomi.*
  - Fam.: Hypodontidæ, Cestraciontidæ, Notidanidæ, Spinacidæ, Scylliidæ, Nictitantes, Lamnidæ, Alopecidæ, Scymniidæ, Squatinæ, Zygænidæ, Pristidæ, Rhinobatidæ, Torpedinidæ, Raiidæ, Trygonidæ, Myliobatidæ, Cephalopteridæ.
- Order 15. *Holocephali.*
  - Fam.: Chimæroida, Edaphodontidæ.
- Order 16. *Protopteri.*
  - Fam.: Sirenoidei.
- Order 17. *Placoganoidei.*
- Order 18. *Ganoidei.*
  - Fam.: Salamandroidei, Pycnodontidæ, Lepidoidei, Sturionidæ, Acanthodei, Dipteridæ, Cephalospidæ.
- Order 19. *Lophobranchii.*
  - Fam.: Hippocampidæ, Syngnathidæ.
- Order 20. *Pleotognathi.*
  - Fam.: Balistinæ, Ostraciones, Gymnodontes.
- Order 21. *Acanthopteri.*
  - Fam.: Percidæ, Sclerogenidæ, Sciænidæ, Labyrinthobranchii, Mugilidæ, Notacanthidæ, Scomberidæ, Squamipennes, Tænioidei, Thentyidæ, Fistularidæ, Gobiidæ, Blenniidæ, Lophiidæ.
- Order 22. *Anacanthini.*
  - Fam.: (Apodes) Ophidiidæ, (Thoracici) Gadidæ, Pleuronectidæ.
- Order 23. *Pharyngognathi.*
  - Fam.: (Malacopterygii) Scomberesoxidæ, (Acanthopterygii) Chroniidæ, Cyclolabridæ, Ctenolabridæ.
- Order 24. *Malacopteri.*
  - Fam.: (Apodes) Symbranchidæ, Murænidæ, Gymnotidæ, (Abdominales) Heteropygii, Clupeidæ, Salmonidæ, Scopelidæ, Characini, Galaxidæ, Esocidæ, Mormygridæ, Cyprinodontidæ, Cyprinidæ, Siluridæ.
- Order 25. *Dermopteri.*
  - Fam.: Amphioxidæ.
- Order 26. *Cyclostomi.*
  - Fam.: Myxinidæ, Petromyzontidæ.

Hæmatology (Gr. *αἷμα*, and *λόγος*). The doctrine of the blood.

Hæmatosine (Gr. *αἷμα*). The red colouring matter of the blood.

Hæmatoxyline. The colouring principle of the wood of the *Hæmatoxylon campechianum* or logwood.

Hæmatoxylon (Gr. *αἷμα*, and *ξύλον*, *wood*). The Logwood-tree, *H. campechianum*, is one of the most useful and important of dye woods. It forms a tree of about forty feet high, the smaller branches covered with white bark and often spiny, the leaves pinnate with few small leaflets, and the flowers yellow in axillary racemes. It belongs to a peculiar group of Leguminous plants called *Cæsalpinieæ*, and is a native of the bay of Campeachy in Yucatan. The wood is of a deep dull brownish red, and is imported in logs of about three feet long.

Hæmaturia (Gr. *αἷμα*, and *οὖρον*, *urine*). A discharge of bloody urine.

Hæmodoraceæ (Hæmodorum, one of the genera). A natural order of Endogens of the Narcissal alliance, principally inhabiting New

Holland. They differ from *Amaryllidaceæ* in their flowers and equitant leaves; from *Iridaceæ* in their stamens, and in their anthers bursting inwards. They are curious, but not useful or beautiful plants; except in the case of *Anigoxanthus*, a genus containing some striking herbaceous species.

Hæmoptysis (Gr. αἷμα, *blood*, and πτύω, *I spit*). The coughing up of blood, sometimes produced by fulness of the blood-vessels of the lungs, or by the rupture of blood-vessels as a consequence of ulceration. It is distinguished from blood coming from the stomach by its usual florid colour: the latter is generally blackened by the acid, and often mixed with the contents of the stomach. The age at which this disease commonly shows itself is from fifteen to five-and-twenty, and it is sometimes brought on by violent exercise or a fit of coughing. It is not very uncommon as a symptom of suppression of some natural evacuation; and when unattended by symptoms of consumption and constitutional cough, and occurring in persons otherwise strong and healthy, it is often not dangerous. Bleeding, aperients, acids, diaphoretics, nauseants, and occasionally the exhibition of small doses of sugar of lead and of styptic astringents, are the remedies usually resorted to.

Hæmorrhage (Gr. αἱμοῤῥαγία, from αἷμα, and ῥήγνυμι, *I break*). A bleeding or flow of blood. This may arise from two causes: either a full state of the vessels, or *plethora*, when it has been called *active hæmorrhage*; or from a debilitated state of the vessels, or of the system generally, when it is called *passive hæmorrhage*. When hæmorrhage occurs from either of these causes, it usually requires methods of treatment adapted to the particular case. Where hæmorrhage is the consequence of wounds, the bleeding vessels must be secured by ligature; or where this cannot be done, styptics are applied.

Hæmorrhoids (Gr. αἱμοῤῥοΐδες, from αἷμα, and ῥέω, *I flow*). Tumours of the veins of the rectum, constituting the disease commonly called *piles*.

Hæresiarch or **Heresiarch** (Gr. αἱρεσίαρχος). In Ecclesiastical History, the founder of an heretical sect. [Heresy.]

Hæretico Comburendo (Lat.). The title given to the writ which ordered the execution, by burning, of persons delivered over by the spiritual to the secular court for heresy.

Hagfish. A vernacular name for a species of cyclostomous fish, called *Myxine glutinosa*, and *Gastrobranchus cæcus*, by ichthyologists.

Hagiographa (Gr.). The Holy Scriptures. The term is also applied to histories or legends respecting the lives and actions of the saints.

Haidingerite. A double sulphide of antimony and iron, named after Haidinger.

Hail (Ger. hagel). Hail occurs chiefly in spring and summer, not unfrequently accompanied with thunder. It is formed of rain congealed by cold in the upper regions of the atmosphere. On an attentive examination of their interior structure, hailstones are usually found to contain an opaque nucleus of a spongy or porous texture, resembling hardened snow, surrounded by a layer of ice of greater or less transparency. Sometimes several transparent layers are distinguishable, and sometimes the layers are alternately transparent and opaque. Hailstones have also been observed having a radiating structure. Their form varies greatly; in general it is roundish, but sometimes pyramidal, angular, or even thin and flat, with irregular surfaces. The usual size of hailstones is about an eighth to a quarter of an inch in diameter; but they are frequently of much greater magnitude, and instances are on record in which the dimensions would appear incredible, if they were not attested by observers of known character. Halley relates that on April 9, 1697, there fell in Flintshire hailstones which weighed 5 ounces. On May 4, 1697, Robert Taylor, in Hertfordshire, observed hailstones which measured 14 inches in circumference; that is, about 4 inches in diameter. Parent, on May 15, 1703, found them at Iliers as large as his fist. On July 11, 1753, at Toul, some were collected by Montiguot measuring 3 inches in diameter. Volta affirms that on the night of August 19, 1787, in a hailstorm which ravaged the city of Como and its environs, some of the stones were found to weigh 9 ounces. In the terrible hailstorm which traversed the whole of France and the Netherlands on July 13, 1788, M. Tessier relates that hailstones were picked up which weighed 8 ounces. And Dr. Noggerath informs us that on May 7, 1822, hailstones fell at Bonn, weighing from 12 to 13 ounces. From such accounts we may form some idea of the destruction occasioned by a severe hailstorm in a cultivated country.

Of the different circumstances accompanying a fall of hail, the following are the most remarkable: Hail usually precedes storms of rain, sometimes accompanies them; but never, or very rarely, follows them, especially if the rain is of any duration. The time of its continuance is always very short, generally only a few minutes, and very seldom so long as a quarter of an hour. The quantity of ice which falls from the clouds in so short a time is prodigious, the ground being sometimes covered with it to the depth of several inches. The clouds from which hail is precipitated appear to be of very considerable extent and depth, as they produce a great obscurity. It has been remarked that they have a peculiar grey or reddish colour, and that their lower surfaces present enormous protuberances, while their edges exhibit deep and numerous indentations. Hail is always accompanied with electric phenomena.

Various hypotheses have been proposed to explain the physical cause of hail, and the phenomena by which it is accompanied; but notwithstanding all that has been written on the subject, the theory of hail is still involved in great obscurity.

Hair (Ger. haar). The characteristic co-

vering of the Mammiferous class of animals. It consists of slender more or less elongated horny filaments, secreted by a matrix, consisting of a conical gland or bulb, and a capsule, which is situated in the mesh-work of the corium or true skin. The hairs pass out through canals in the corium, which are lined by a thin layer of cuticle adherent to the base of the hair: the straightness or curl of the hair depends on the form of the canal through which it passes. Spines, bristles, fur, and wool are all modifications of hair, having the same chemical composition, mode of formation, and general structure.

In the spines of the porcupine the bulb secretes a fluted pith, and the capsule invests it with a horny sheath, the transparency of which allows the ridges of the central part to be seen. In the spines of the hedgehog, the spine-like whiskers of the walrus, and the bristles of the hog, the twofold structure of the hair is very conspicuous; but in the finer kind of hair, as of the human head and beard, the central pith can only be demonstrated in fine transverse sections viewed with a microscope. Some kinds of hair, as of the human head, and that of the mane and tail of the horse, are perennial, and grow continuously by a persistent activity of the formative capsule and pulp; other kinds, as the ordinary hair of the horse, cow, and deer, are annual, and the coat is shed at particular seasons. In the deer the horns are shed contemporaneously with the deciduous hair.

Many quadrupeds, especially those of cold climates, have two kinds of hair: a long and coarse kind, forming their visible external covering; and a shorter, finer, and more abundant kind, which lies close to the skin, and is called *fur*. It is one of the processes in the arts to remove the coarse hair, and leave the fur attached to the dried skin, as in the preparation of seal-skin, &c. The peculiar characteristic of wool, and that on which its valuable qualities chiefly depend, is the serrated character of its surface, arising from its structure, which consists of a series or succession of inverted cones, the base of each being directed from the root of the woolly fibre, and receiving the apex of the succeeding cone. It results from this structure that the pressure to which the workman subjects the wool in moving it backwards and forwards, brings the fibres together and multiplies their points of contact. The agitation gives to each hair a progressive motion towards the root, and the serrations of one hair fix themselves on those of another hair which happens to have its root turned in the opposite direction, and the mass at length assumes that compact form which is termed *felted* wool. The microscope has likewise demonstrated various other remarkable modifications in the form of the hair in different quadrupeds. In the mole, for instance, each hair is alternately constricted and expanded from its root to its apex, whereby it readily assumes any position, and lies flat and moving forwards. The organisation of the hair is such as to allow of its undergoing certain changes when once formed, according to the state of health and general condition of the rest of the frame. Some of the lower animals, as the Alpine hare, are subject to periodical change of colour of their fur, by which it is made to harmonise with the prevailing hue of the ground which they habitually traverse.

The chemical properties of hair were first pointed out by Mr. Hatchett, in his paper in the *Phil. Trans.* for 1800. It chiefly consists of an indurated albumen, and when boiled with water it yields a portion of gelatine. Soft flexible hair, which easily loses its curl, is that which is most gelatinous. Vauquelin discovered two kinds of oil in hair: the one colourless, and in all hair; the other coloured, and imparting the peculiar tint to hair. Black hair also contains iron and sulphur.

Hair, Colour of.—The prevalent popular belief that the hair of persons under strong emotions of grief or terror undergoes a change of colour, does not appear to rest on any sure foundation. Haller, in his *Elementa Physiologiæ*, refers to eight authorities for examples of such changes, admitting that under the influence of impaired health such a change may take place slowly. The case of Marie Antoinette comes under the condition admitted by Haller. Had it been possible for mental emotion, whether of terror or of grief, to render hair suddenly grey, surely in the queen's case the change should have been witnessed at an earlier period than that of the arrest of the royal family in their attempt to leave France. No authentically recorded instance of such change has been ascertained to take place amongst men prematurely worn out in various climates, or amongst soldiers engaged in an active campaign amidst all the dangers and horrors of war. The *Transactions of the Royal Society*, extending over 200 years, do not contain an instance of such change in the colour of the hair; a circumstance opposed to the conclusion that it ever took place, for had it ever been undoubtedly witnessed, it is not likely it would have remained undescribed. (Dr. J. Davy, British Association, 1861.)

Hair Pencils. A term applied by artists to the small brushes used in painting, and often termed *camel's hair* pencils; they are composed of fine hairs, especially of the martin, badger, minever, polecat, &c., and are mounted, when small, in quills; but when larger, in tinned iron tubes.

Hair Salt. Efflorescent sulphate of magnesia.

Hair Trigger. [TRIGGER.]

Hair's Breadth. The forty-eighth part of an inch is sometimes so called.

Hairs. In Botany, minute transparent filiform processes, composed of cellular tissue more or less elongated and arranged in a single row.

protectors of the surface in which they grow. Many sorts are distinguished, the principal of which are the secreting or glandular hairs, which are composed of cellules that are visibly distended either at the apex or base into receptacles of fluid; and the lymphatic, which consist of tissue tapering gradually from the base to the apex.

Hairbell. The *Campanula rotundifolia*, a wild flower common in chalky pastures and wastes. The name is sometimes written Harebell. It is the Blue-bell of Scotland.

Halberd or **Halbert** (Mr. Wedgwood connects this word with the Swiss halm, *a handle*, and Ger. barte, *a broad axe*). An offensive weapon, consisting of a long pole or shaft, with a steel head somewhat in the form of an axe, with a spike or hook at the back. It was much used in the English army in the sixteenth century, and gave its name to troops called *halberdiers*, to whom was confided the defence of the colours, with other special duties. It is now rarely to be met with except in some boroughs in Scotland, where it is used by the civic officers who attend the magistrates on public occasions.

Halcyon. [ALCEDO.]

Halcyon Days. A name given by the ancients to the seven days that precede and follow the winter solstice, from the circumstance of the halcyon or alcedo selecting that period for incubation. While this process was going on, the weather was generally remarkable for its calmness; and hence the expression has passed into a proverb, signifying days of peace and tranquillity.

Halcyonidæ (Gr. ἀλκυών, *a kingfisher*). The family of Fissirostral birds, having the kingfisher as the type.

Half-moon. In Fortification. [DEMILUNE; RAVELIN.]

Half-pay. In the Army, is granted as a remuneration for past military services, either to an officer who retires altogether from active duty after twenty-five years' service, or to one who is compelled by some exceptional causes, as ill-health, reduction of his regiment, &c., to quit active service for a time. In the latter case the receipt of half-pay involves an obligation to return to duty when called upon, unless physically disqualified. The rates of half-pay are somewhat in excess of half the rates of full pay. The laws concerning half-pay, its liabilities and its rights, are extremely complicated, and will be found at length in the War Office Regulations.

In the Royal Navy, half-pay has more the nature of a retaining fee. Active employment is exceptional (during peace) in the higher ranks, and in the lower ranks it is frequently not to be had. When this is the case, the officer is placed on half-pay, often for years together. When an officer is too old for service he *retires* on half-pay, generally obtaining a step of honorary promotion.

The charge in 1865 is:—

For Army half-pay .	. £342,486
For Navy half-pay .	. 698,195
Total	£1,040,681

Haliotidæ (Gr. ἅλς, *the sea*, and οὖς, *the ear*). A family of Gasteropodous Mollusca, having as its type the genus *Haliotis*, or the [illegible]

Halispongia (Gr. ἅλς, *the sea*, and σπόγγος, *a sponge*). The generic type of a group of sponges distinguished by the presence of *silicious* spiculæ.

Halitherium (Gr. ἅλς, *sea*, and θηρίον, *beast*). A genus of *Sirenia*, allied to the Manatee; its teeth were erroneously referred by Cuvier to the genus *Hippopotamus*. It is found in the Miocene deposits.

Halitus (Lat. *vapour*). In Physiology, this term is applied to the vapour which rises from newly-drawn blood, and which has a peculiar odour.

Hall. [COLLEGE.]

Hallelujah (Heb. *praise ye the Lord*). A well-known doxology, derived from the Old Testament. It was used, among the early Christians, at Easter, and during the interval thence to Whitsuntide.

Halliards, Haulyards, or **Halyards.** Ropes by which signals are hoisted.

Hallite. The subsulphate of alumina found at Halle.

Hallowmas. The time from November 1 to February 2, or Candlemas, was so called. [ALL-HALLOWS.]

Halloylite. A mineral named after M. d'Halloy. It is a hydrated silicate of alumina.

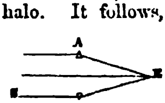
Halo (Lat. halos, Gr. ἅλως). In Meteorology, a luminous circle or ring, usually coloured, surrounding the sun or moon under certain conditions of the atmosphere. Of such rings there are two kinds, each apparently depending on essentially different physical causes. The first are of small dimensions, their diameters being between 5° and 12°; generally three or more concentric rings appear together, differently coloured, and presenting appearances similar to the optical phenomena of the rings of thin plates. These are usually called *coronæ*; and they appear either when a small quantity of aqueous vapour is diffused through the atmosphere, or when light fleecy clouds pass over the sun or moon. The second kind consists usually of a single luminous ring, but of much larger dimensions, the diameter being about 45°. It is to appearances of this second kind that the term *halo* is usually appropriated.

The apparent diameters of halos of the second kind have frequently been measured, and are always found to subtend at the eye of the observer an angle of between 44° and 46°. The lunar halo is simply a white luminous circle, without colour, excepting a pale red, which sometimes fringes the interior edge of the circle. But the colours of the halos about the sun, though not so bright as those of the rainbow, are marked with sufficient distinctness. The red occupies the interior part of the luminous circle; the indigo and violet the outer part, shading away by insensible degrees till they are blended with the general colour of the sky. In some circumstances a second halo is observed concen-

tric with the former, but of much larger extent, its apparent diameter being about 90°. The colours of this secondary halo are faint and pale, and its luminousness much inferior to that of the inner halo. The halos are very frequently attended by a horizontal white circle, with brighter spots, or *parhelia*, near their intersections with the circle, and with portions of inverted arches of various curvatures. [PARHELIA.]

Various causes have been assigned for the origin of halos; but the most probable is that of Mariotte, who supposes the phenomenon to arise from the *refraction* of light in passing through small transparent and prismatic crystals of ice floating in the higher regions of the atmosphere.

Water assumes, in congealing, a great variety of crystalline forms, among which are most frequently found crystals whose faces are inclined to each other in an angle of 60°; thus forming prisms of ice of which the refracting angle is 60°. These prisms are turned in all possible directions, and consequently the sun's rays fall on their faces at all different inclinations. But in certain positions of the prism with respect to the incident light, the rays which traverse it suffer a minimum deviation; this happens when the refracted ray makes an isosceles triangle with the two sides of the prism. The path of the ray in the interior of the crystal in this case makes an angle of 60° with the face of the crystal, or an angle of 30° with the perpendicular to that face This last angle is the angle of refraction; and it is known by experiment that in the case of ice, the angle of refraction being 30°, the angle of incidence is 41°; hence the ray falls on the crystal at an angle of $90° - 41° = 49°$; consequently the deviation of the ray from its original direction is $60° - 49° = 11°$. On escaping from the crystal, the ray suffers a second flexure of the same amount; and the total deviation from its first direction is now $2 \times 11° = 22°$, which is the semidiameter of the halo. It follows, therefore that the parallel rays S A, S B, from the sun falling on such prisms, at A and B at angles of incidence equal to 41°, will be refracted into the directions A E and B E, which make angles A E S and B E S equal to 22°; and an eye situated at the intersection E will see a luminous circle of which the apparent diameter, or angle A E B, is about 44°. With respect to the secondary or external halo, whose diameter is about 90°, it may be attributed, says Dr. Young (*Lectures*, vol. i. p. 348), either to two successive refractions through different prisms, or with greater probability, as Mr. Cavendish suggested, to the refraction of the rectangular terminations of the prisms.



This theory explains the order in which the colours are disposed. The ratio of the refraction of the violet ray being greater than that of the red ray, the former will suffer a greater deviation, and consequently the violet band of the halo will have a greater diameter than the red. Supposing this theory to be correct, the condition necessary for the appearance of halos is the existence of particles of ice in the upper regions of the atmosphere. The appearance of a halo, therefore, furnishes information respecting the temperature of the air at great altitudes above the earth.

The parhelic, horizontal, and vertical circles which are white are due evidently to *reflexion*. They are never observed unless a *cirrus* or *cirro-stratus* cloud is between the spectator and the luminary which gives rise to them.

The formation of *coronæ*, or the small halos so frequently seen round the sun and moon in fine weather, is ascribed by Fraunhofer and Sir John Leslie, not to the *refraction* but to the *diffraction* of light in passing by the small watery globules suspended in the atmosphere. If a piece of tinfoil punctured with the point of a needle be held close to the eye, the sun will appear through it surrounded with a halo very near his disc, but spreading more in proportion as the hole is contracted. Supposing that an aqueous globule of equal dimensions would produce an equal diffraction, the magnitude of the globules might thus be inferred from the diameter of the halo. When the halo approaches nearest to the luminous body, the largest globules are floating, and therefore the atmosphere is surcharged with humidity; whence the justness of the remark that a dense halo close to the moon portends rain. For a full exposition of the theory of halos and other similar meteors, the reader is referred to a Memoir by Fraunhofer in Schumacher's *Astronomische Abhandlungen*, 3tes heft; or to the article 'Hof,' in Gehler's *Physicalisches Worterbuch*. See also Newton's *Optics*; Smith's *Optics*; Pouillet, *Élémens de Physique*; *Cabinet Cyclopædia*, art. 'Optics;' *Encyclopædia Britannica*, art. 'Meteorology.'

Halogens (Gr. ἅλς, *salt*). Substances which by combination with metals produce saline compounds; such as chlorine, iodine, bromine, fluorine, which are simple halogens; and cyanogen, which is a compound halogen.

Haloragaceæ (Haloragis, one of the genera). An order of water plants belonging to the Myrtal alliance, of little use generally, though *Trapa natans* and other species furnish fruits with edible kernels, and are sometimes called *water-chestnuts*.

Haltica (Gr. ἁλτικός, *good at leaping*). A genus embracing numerous species of small and often minute Coleopterous insects, of the family *Galerucidæ*, and section *Tetramera*. These insects have the femoral joints of the hind legs thick and strong, and are consequently good leapers. The native species are smaller than the foreign ones, but are more noxious than might be expected from their diminutive size. The notorious turnip-fly, or rather turnip-flea (*Chrysomela nemorum* of Linnæus), is a species of the present genus.

Hamadryads (Gr. ἁμαδρυάδες). Nymphs supposed by the Greek and Roman poets to live and die with the trees to which they were attached.

Hamamelidaceæ (Hamamelis, one of the genera). A small order of epigynous Exogens, of the Umbellal alliance, consisting of small trees or shrubs found in various parts of the world, and allied on the one hand to *Bruniaceæ*, and on the other to *Cornaceæ*.

Hamites (Lat. hamus, *a hook*). A genus of extinct Cephalopods, which inhabited chambered shells, losing their spiral form soon after their commencement and then continued for a considerable extent with a single bend upon themselves like a hook. The *Hamites* are found in the greensand formation in England.

Hamlet (dim. of A.-Sax. ham, *home* or *house*). A small village. In Law, a hamlet is a portion of a village or parish; according to Stow, the word meant originally the seat of a freeholder.

Hammer Beam. In Architecture, a horizontal piece of timber from, or near, that above the foot of a rafter, the object of which is to counteract the tendency of the rafter to an outward thrust. It is only used in Gothic roofs, and is of value as providing a counterbalance to the weight of the rafter.

Hammer of a Musket. That part of the lock which descends violently upon the percussion cap when the trigger is pulled.

Hammock (Span. hamaca). The sailor's bed. An oblong piece of hempen cloth; at each end are fastened several small lines, meeting in a grummet or iron ring; these form the *clews*. The whole, having a mattress and pillow, &c. placed in it, is hoisted up into its place by small ropes called *lanyards*, and suspended from hooks in the beams of the deck overhead, about nine feet asunder. The hammock is a very agreeable bed, especially in cold weather; but some little practice is needed at first to get in and out successfully. During the day the hammocks, lashed up tight with the mattresses and bedding rolled within, are stowed in the nettings along the upper edge of the bulwark.

In the language of some tribes in the West Indian islands, the word *hamac* denoted nets of cotton extended from two posts, and used as beds. From them the word was borrowed by the companions of Columbus, who transferred it to us through the Spanish word *hamaca*.

Hamster (a word of Ugrian origin). In Zoology, the *Mus Cricetus* of Linnæus, a rodent quadruped, somewhat larger than a rat, common in all the sandy regions that extend from the North of Germany to Siberia; extremely noxious from its fertility and great destruction of grain, but an object of interest on account of the economic instincts which conduce to its preservation and support. The hamster excavates a complicated burrow, consisting of different apartments for rearing the young, hibernating, and storing up winter food, often in enormous quantity. To effect this hoard, nature has provided the hamster with a means of transport in two large cheek-pouches, which, during its incursion among cultivated grounds, it crams full of grain, beans, or peas, and empties on its return to its hole by pressing the two fore-paws against the cheeks. The hamster, however, is not wholly dependent upon its winter store for existence. During the inclement months, when the frost becomes severe, animation is in great measure suspended: respiration ceases, the animal heat falls, and a kind of vegetative life is maintained by a slow circulation of dark or venous blood through both sides of the heart. When the returning warmth of spring stimulates the organic machinery to its wonted activity, the awakened hamster finds in the nourishment which it has stored up the means of supplying the consequent waste, and of maintaining its vital energies. They are thus enabled to commence the business of procreation in April, and the female rears a litter of six or eight twice or thrice every year. In about three weeks the young are able to provide for themselves, and are driven from the holes of the parents. The hamster is the type of the genus *Cricetus* of Cuvier, characterised by the short tail and cheek-pouches. The teeth nearly resemble those of the rat.

Hanaper Office. A common law office in the Court of Chancery, in which writs were anciently kept in small separate wicker baskets (hampers, *hanaperia*), abolished by 5 & 6 Vict. c. 103, and duties transferred. Writs relating to the subject were deposited there; those concerning the crown in the Petty or Little Bag, whence another office of the same court is denominated.

Hand (a word common to all Teutonic dialects). A measure of four inches, by which the height of a horse is computed: also the parts of a horse—as *forehand*, for the head, neck, and fore quarters; and *hindhand*, which includes the rest. It also designates the hand of the rider; the *spur-hand* being the right hand, and the *bridle-hand* the left.

Hand Grenade. [GRENADE.]

Handloom. [WEAVING.]

Handspike. A stout ashen pole, seven feet in length, used as a lever in the service of ordnance. It is round at the handle, and square towards the other end, the extremity of which is bevelled. When the handspike is used as a lever of the first kind, the bevelled side should be down; when used as a lever of the second kind, the bevelled side should be uppermost.

HANDSPIKE. A wooden lever employed on board a ship in working the windlass and capstan, one end being squared to fit the holes in the capstan head and in the barrel of the windlass.

Hank. In Spinning, the name given to two or more skeins of yarn, silk or cotton, when tied together. When single, they are called *skeins*.

Hanks. Rings of ash or iron, by which fore-and-aft sails are confined to the stays on which they are severally suspended and upon which stays the hanks slide while the sail is in process of being set or hauled down.

Hanno's Periplus. [PERIPLUS.]

Hanse, or **Hanseatic League** (Ger. hanse, Gothic hansa, *a league*). In European History, a celebrated confederacy of cities on the coasts of the Baltic, and in the adjoining countries. The first league was formed in 1239, between Hamburg, Minden, and many other towns, to which Lübeck soon afterwards acceded: it was for the purpose of mutual defence against foreign potentates, especially the Danish king Waldemar, as well as the neighbouring nobles of Germany. The league rapidly spread, and comprehended, at one period, eighty-five cities, divided into four provinces. It had four chief foreign dépôts: at London, Bruges, Novgorod, and Bergen. In the fourteenth and fifteenth centuries the league became of high political importance, and made war and peace as an independent sovereign power, but it was never recognised by the German empire. Its decay was gradual, as the increased protection given to commerce by the princes of the several states in which these cities were situated rendered the alliance for mutual defence unnecessary.

Haquebut, Harquebus, Hackbut. [Arquebuse.]

Harbour (Ger. herberge). A piece of navigable water communicating with the sea or with a navigable river, or lake, deep enough to receive large vessels, and protected from the effects of storms or heavy seas. Harbours must always be accompanied by a roadstead, in which vessels may await the high tides, if the harbour should be exposed to their action; and in all cases it is preferable that there should be an outer harbour, in which the ships frequenting the particular port should be able to bring up or to lose the way they retain from the open sea. Harbours are divided into harbours of refuge, tidal, and permanent harbours. In harbours of refuge all that is needed is to secure facility of entrance and safe berths for the vessels lying in them, together with great facilities for putting to sea; but as the vessels frequenting harbours of this class are usually destined for some other port, there will be no necessity for making enclosed docks where the ships might be free from the inconvenience of the tides. In tidal harbours such enclosed docks are wanted; for large vessels are rarely so built as to allow of their being beached, or unloaded upon the beach, when the ships are left by the tide. Permanent harbours may dispense with the works for the enclosure of the shipping; but they will be always unfit for the purpose of a commercial port, as ships unless always at the same level cannot be economically unloaded; in such seas as the Mediterranean, the Caspian, and the great lakes of America, this remark does not apply. Practically, permanent harbours are either military or civil. The first require large areas of water surface, where the ships may lie in ordinary, as at Plymouth, Portsmouth, Cherbourg, Brest, Toulon, &c.; the latter are usually smaller, and more compact, as Southampton, Falmouth, Liverpool, Glasgow, London, Havre, Bordeaux, &c.

Hard Bodies. In Natural Philosophy, bodies which resist pressure or percussion: in opposition to soft bodies, the parts of which readily yield to pressure, and do not recover themselves; and to elastic bodies, the parts of which also yield to pressure or impact, but presently recover themselves when the disturbing force ceases to act.

Hardness. In Mineralogy. Minerals may occasionally be distinguished and identified by their relative degrees of hardness; to specify which, various scales have been suggested, that of Mohs being perhaps the most simple. According to it the relative degrees of hardness are expressed in numbers, referring to the following standard substances, which are easily obtained in a state of purity, or crystallised; namely—

1. Talc.	6. Adularia (Felspar).
2. Rock-salt.	7. Rock-crystal
3. Calc-spar.	8. Topaz.
4. Fluor-spar.	9. Corundum.
5. Apatite.	10. Diamond.

Any mineral which neither scratches nor is scratched by any one of the above substances is said to possess the hardness expressed by the attached number. Thus if a mineral neither scratches nor is scratched by calcareous spar, its hardness is represented by 3; if it scratches felspar and not rock-crystal, its hardness is stated to be between 6 and 7.

Hardware. A generic term employed to signify such manufactures as are produced from the commoner or more useful metals; that is, iron and steel, brass and copper, zinc and tin, and occasionally certain commoner kinds of plated goods. The industry which is engaged in these products is seated chiefly in Warwickshire and certain parts of Yorkshire, and particularly in the towns of Birmingham, Wolverhampton, and Sheffield, though it is carried on also in many other localities.

According to the census of 1861, 117,418 persons were engaged in the manufacture of machines, 13,744 in that of arms, 316,572 in that of iron and steel, 45,577 in that of brass, 9,733 in that of copper, 760 in zinc. If we add to these the moiety of those engaged in tin and quicksilver manufactories, viz. 11,439, the aggregate of persons employed in the hardware industry is 515,243; and if we take the wages paid to such persons to average 15*s*. a week, and to represent the third in value of the commodities produced, the annual value of the hardware manufactured in England will amount to upwards of 60,000,000*l*. In all likelihood, however, this estimate is below the truth.

Hare. [Lagomys; Lepus.]

Harebell. The *Hyacinthus non scriptus*, a wild flower common in woods and hedgerows, and sometimes called *Blue-bell*. [Hairbell.]

Harelip. A fissure or perpendicular division of the lip, so named from its supposed resemblance to the upper lip of a hare. Children are sometimes born with this malformation, and sometimes it is the consequence of accidents

or wounds. It most usually affects the upper lip; and is not only a serious deformity, but may prevent the infant from sucking and cause impediment of speech. The cleft is sometimes double. This malformation admits of partial or entire relief by a surgical operation, which should generally not be performed upon very young infants, as there is a risk of causing convulsions.

Harem (Turk.). The name given to those apartments in the houses of the East which are appropriated exclusively to females. [SERAGLIO.]

Haricot (Fr.). The ripe seeds of various kinds of kidney bean, especially of *Phaseolus vulgaris*; used in cookery.

Harits. [CHARITES.]

Harlequin. In the Italian Comedy, the name given to the person who performs a part something similar to that of the clown or merry-andrew of the mountebank stages in our own country. Harlequin forms also one of the standing characters in the grotesque entertainments of the pantomime. The name is said to be derived from an Italian comedian who, from frequenting the house of M. de Harlay at Paris in the time of Henry VII., was called Harlequino or little Harlay. [PANTOMIME.]

Harmaline. A crystallisable alkaloid contained in the seeds of the *Peganum Harmala.*

Harmattan. The dry parching wind prevailing on the coast of Africa, between Cape Verd and Cape Lopez, in the months of December, January, and February.

Harmonia (Gr. Ἁρμονία). In Greek Mythology, according to some versions, a daughter of Ares and Aphroditê. She became the wife of Cadmus, the founder of Thebes, from whom she received the fatal necklace which brought about the deaths of Amphiaraos and Eriphylê. [EUROPA.]

Harmonic Axes. The harmonic axes of the r^{th} order, of any number n of rays of a plane pencil with respect to a fixed ray, are the r rays which pass through the harmonic centres, of the r^{th} order, of the n points in which the given rays cut any transversal; these centres being taken with respect to the point in which the same transversal is cut by the given fixed ray. [HARMONIC CENTRES.] The properties of such harmonic axes are correlative to those of harmonic centres.

Harmonic Centres. The harmonic centre of two points a_1, a_2 with respect to a pole o, in the same line with them, is, simply, the *harmonic conjugate* of o with respect to a_1 and a_2. Calling it m, it is determined by the relation

$$oa_1 \qquad oa_2$$

where each segment ma is to be understood as having a sign determined by the direction of the motion from m to a.

More generally m is said to be the harmonic centre, relative to o, of any number n of points a when

$$\Sigma\left(\frac{ma}{oa}\right)=0,$$

where the summation extends to the n fractions of which $\frac{am}{oa}$ is a type. Such a centre m was formerly called by Poncelet the *centre of the harmonic mean* (Crelle's *Journal*, vol. iii.); further investigations, however, have led Jonquières and others to the consideration of harmonic centres of higher order; those of the r^{th} order being defined by the equation $\Sigma\left(\frac{ma}{ao}\right)_r=0$, where $\left(\frac{ma}{oa}\right)_r$ represents a product of r factors, of the type $\frac{ma}{oa}$, but formed by taking for a, successively, any r of the given points, and the sign Σ extends to all the different products that can be so formed. An equivalent definition is given by the equation

$$\Sigma\left(\frac{1}{om}-\frac{1}{oa}\right)_r=0;$$

whence it is manifest that there are always r harmonic centres of the r^{th} order. The harmonic centre of the first order is defined by the equation

$$\frac{n}{om}=\frac{1}{oa_1}+\frac{1}{oa_r} \qquad \frac{1}{oa_n};$$

that is to say, om is the ***harmonic mean*** of the segments oa_1, oa_2, &c. . .

Amongst the most important properties of harmonic centres are the following:—

1. If m be one of the harmonic centres, of the r^{th} order, of a given system of points with respect to a pole o, the latter is also a harmonic centre, of the $(n-r)^{th}$ order, of the same system with respect to the pole m.

2. The pole o being invariable, the harmonic centres of the r^{th} order of a given system of points coincide with the harmonic centres, of the same order, of the harmonic centres of any superior order.

3. If m_1, m_2 . . . m_r be the harmonic centres, of the r^{th} order, of a given system of points, with respect to a pole o, and m_1', m_2', . . m_r', those of the r'^{th} order of the same system of points with respect to another pole o', then the harmonic centres of m_1, m_2, . . m_r of the $(r+r'-n)^{th}$ order, with respect to o', will coincide with the harmonic centres of the order $(r+r'-n)$, of m_1', m_2' . . m_r' with respect to o.

4. The projections upon any other line of a number of points, of their harmonic centres of any order, and of the corresponding pole, retain all the properties of the original system.

The theory of harmonic centres plays an important part in modern geometry. Cotes, in his *Harmonia Mensurarum*, first showed that the locus of the harmonic centre, of the first order, with respect to a fixed pole o, of the intersections of a curve of the n^{th} order by a line which passes through that pole, is always a right line. It is now called the $(n-1)^{th}$ *polar* (or *polar line*) of o; the r^{th} polar of o being the locus of harmonic centres of the $(n-r)^{th}$ order of the same intersection points.

Harmonic Mean. The second term of the harmonic progression whose first and third

terms are given quantities, is termed the *harmonic mean* of the latter. Hence, since the reciprocals of quantities in harmonic progression form an arithmetic series, the harmonic mean is the reciprocal of one half the sum of the reciprocals of the given quantities. Generalising this definition, the harmonic mean of any number of quantities is the reciprocal of the n^{th} part of the sum of their reciprocals.

Harmonic Pencil of Rays. A system of four lines through a point such that one of the three fundamental anharmonic ratios to which they give rise has the value -1. [ANHARMONIC RATIO.] Thus the pencil whose rays are OA, OB, OC, OD will be harmonic if

$$\sin(ABCD)=\frac{\sin AOC}{\sin COB}\div\frac{\sin AOD}{\sin DOB}=-1.$$

A harmonic pencil cuts every line in its plane harmonically, that is to say in a harmonic row of points, and all pencils are harmonic whose rays pass through four fixed harmonic points. Harmonic pencils and harmonic rows, therefore, have correlative properties. The term *harmonic conjugates* is applied, in the above case, to the two rays A and B, as well as to the two C and D. Three rays of a pencil being given, the harmonic conjugate of any one with respect to the two others is perfectly defined, and may easily be constructed by means of the properties of a complete quadrangle. [QUADRANGLE.] The bisectors of the angles made by two lines are harmonic conjugates with respect to these lines. They are obviously perpendicular to each other, and we may say conversely that when two conjugate rays of a harmonic pencil are at right angles to each other, they bisect the adjacent angles made by the other pair.

Similarly, a *harmonic pencil of planes* is a system of four planes passing through the same line such that, of the three fundamental anharmonic ratios to which they give rise, one has the value -1. Any pencil of planes passing through the rays of a plane harmonic pencil, or through four harmonical points, will be itself harmonic. [ANHARMONIC RATIO.]

Harmonic Progression or Series. A series of numbers such that any three consecutive terms are in harmonic proportion. The principal property of this progression is, that the reciprocals of the terms form an arithmetic progression; and, conversely, the reciprocals of an arithmetic, form a harmonic progression.

Harmonic Ratio. [ANHARMONIC RATIO.]

Harmonic Row of Points. Four points in a line are said to form a *harmonic row* when, of the three fundamental *anharmonic ratios* which they determine, one has the value -1, the others having the values $\frac{1}{2}$ and 2. [ANHARMONIC RATIO.] Thus a, b, c, d will form a harmonic row if

$$(a\,b\,c\,d)=\frac{a\,c}{c\,b}\div\frac{a\,d}{d\,b}=-1,$$

and in this case c and d are said to be *harmonic conjugates* with respect to a and b. The latter are of course also harmonic conjugates with respect to the former, since obviously

$$(c\,d\,a\,b)=-1.$$

Estimated numerically, it is evident that the segment $a\,b$ is the harmonic mean of the segments $a\,c$ and $a\,d$, and that $d\,c$ is the harmonic mean of $d\,b$ and $d\,a$. Further, any two harmonic conjugates divide the line joining the other two into segments, which have the same ratio, the absolute value of the latter being alone considered.

Of two harmonic conjugates with respect to a given pair of distinct points a and b, one is perfectly defined when the other is given; one is always within, and the other without the segment $a\,b$. When one bisects $a\,b$, the other is infinitely distant, and from these extreme positions both move simultaneously towards a (or b), with which they ultimately and simultaneously coincide. The harmonic division of a line occurs very frequently in the higher geometry; it is most conveniently effected, geometrically by means of the properties of the diagonals of a *complete quadrilateral* [QUADRILATERAL]; algebraically it can be shown that if x denote the distance of any point of a line from an assumed origin, in the same, the quartic equation

$$a_0x^4+4a_1x^3+6a_2x^2+4a_3x+a^4=0$$

will represent four harmonic points provided the cubinvariant

$$a_0a_2a_4+2a_1a_2a_3-a_0a_3^2-a_4a_1^2-a_2^3$$

vanishes.

Harmonic Triad. In Music, the chord of a note consisting of a third and perfect fifth, or, in other words, the common chord.

Harmonics. In Music, the doctrine of the mathematical relations of musical sounds to each other. This doctrine was by the ancients divided into seven parts; viz. of sounds, of intervals, of system, of the genera, of the tones or modes, of mutation, and of melopœia.

Harmonica. [MUSICAL GLASSES.]

Harmonical Interval. In Music, any interval which has definite harmonic relations between the numbers of vibrations of its constituent notes.

Harmonical Proportion, called also **Musical Proportion.** Three numbers are said to be in harmonical proportion when the first is to the third as the difference of the first and second is to the difference of the second and third: thus, 2, 3, and 6 are in harmonical proportion, because 2 : 6 :: 1 : 3.

Harmonium. In Music, a musical instrument, somewhat resembling a small organ, and played with a clavier in the same manner. Its tones are produced by reeds, somewhat similar to those in the reed pipes of an organ, but left free at one end, and hence called *free reeds.* These are caused to vibrate by wind from bellows worked by the feet. The harmonium takes the place of an organ in houses or schools and small churches, and has of late years come into very extensive use.

(Gr. ἁρμονία). In Music, an agreeable combination of sounds heard at the same instant. As a continued succession of single musical sounds produces melody, so does a combination of several together produce harmony.

Harmony, Pre-established. A hypothesis invented by Leibnitz, to explain the correspondence between the course of our sensations and the series of changes actually going on in the universe, of which, according to that philosopher and many others, we have no direct knowledge. [PERCEPTION.] This hypothesis is connected, in the Leibnitzian system, with the doctrine of monads—certain spiritual powers or substances, one of which constitutes the principle of vitality and consciousness in every living being. Each of these is, in its degree, a mirror, in which the changes going on in the universe are reflected with greater or less fidelity. But between simple substances, such as spirit and matter, soul and body, no real reciprocal action can take place. The Author of the universe has consequently so ordained that the series of changes going on in any particular conscious monad, corresponds precisely to those of the monads in contiguity to which it is placed. Hence arises our belief that mind is acted on by matter, and vice versâ; a belief which leads to no practical errors in virtue solely of this pre-established harmony. The subject of Leibnitz' theory has recently undergone fresh discussion in Mr. J. S. Mill's work on the *Philosophy of Sir William Hamilton*.

Harmony of the Scriptures, Gospels, &c. The correspondence of the several writers of different parts of the Scriptures in their respective narratives, or statements of doctrine. The earliest Harmony of the Gospels was composed by Tatian, in the second century, with the title *Diatessaron*. Among other works of this kind may be mentioned Osiander, *Harm. Evangelica*; Cartwright, *Harm. Ev. Commentario illustrata*, 1647; Le Clerc, *Harmonie Ev.* Amst. fol. 1699; Macknight's *Harmony of the Four Gospels*, 1756; Greswell, *Harmony and Dissertation*, Oxford 1830.

Harmostes (Gr. ἁρμοστής, from ἁρμόζω, *I fit*). In Ancient History, a Spartan magistrate, called also sometimes *sophronistes* (σωφρονιστής, *moderator*), who was appointed to superintend a conquered state. It is conjectured, from Thucyd. iv. 53, that the office was annual. Other Greek states which made conquests afterwards borrowed the name. Xenophon speaks of Theban *harmostæ* in Achaia.

Harmotome (Gr. ἁρμός, *a joint*, and τέμνω, *I divide*). A mineral chiefly from Andreasberg, in the Harz, the crystals of which often intersect each other, and are easily separable. It is also called Cross-stone or Staurolite. [CROSS-STONE.]

Harp (Ger. harfe). A musical stringed instrument of great antiquity, in which the strings are stretched on a triangularly formed frame, and pinched, or rather pulled, by the fingers, to set them in vibration and produce the different sounds. The harp is represented on many Egyptian monuments; and though it is usually admitted to be of Eastern origin, it seems doubtful whether it was known to the Greeks and Romans in any shape analogous to its present form. Of late years this instrument has been much improved by pedals and other devices.

Harp Shells. [HARPA.]

Harpa (Ger. harfe). A genus of Pectinibranchiate Molluscs dismembered from the Linnæan *Buccinum*, and remarkable for the elegance of form and beauty of the markings of the shell: this is traversed by longitudinal compressed sinuous parallel ribs, which may be compared to the strings of a harp.

Harpalus (Gr. ἁρπαλέος, *grasping, greedy*). A genus of predaceous Coleopterans, and the type of a family (*Harpalidæ*), which is one of the principal divisions of the Linnæan genus *Carabus*.

The *Harpalidæ* are divided into three principal sections, characterised by modifications of the anterior *tarsi* of the male.

1. *Harpalinæ*, having the four anterior tarsi of the males dilated.
2. *Feroninæ*, having the two anterior tarsi dilated, and the joints heart-shaped.
3. *Patellimana*, having the two anterior tarsi of the males dilated; the joints being square or rounded.

Each of these sections contains numerous subgenera, of which *Harpalus proper* contains many British species. *Harpalus ruficornis* is perhaps the most common; it exceeds half an inch in length, with opaque black elytra and body, and red legs and antennæ.

Harpax. A genus of fossil shells, oblong and somewhat triangular, the hinge being formed by two projecting teeth. (Parkinson.)

Harpies (Gr. Ἅρπυιαι, from ἅρπω = ἁρπάζω, *I seize*). In Mythology, a name for the storm-winds. (Gladstone's *Homer and the Homeric Age*, vol. ii. p. 300.) In Hesiod, they are represented as the beautiful daughters of Thaumas and Electra; but in later mythology they assume the repulsive form under which Virgil has exhibited them. (*Æn.* iii. 211 &c.)

Harpings (a word akin to *warping*). In a ship, those planks or wales, forming her outer covering, which bend in towards the bow and are fastened in the stem. They are thicker than other parts of the wales, to encounter the great resistance offered by the water as the ship cuts through it.

Cat-harpings.—Minor ropes between the tops and mastheads, employed to draw the shrouds together and inwards towards the mast. They serve to tighten the shrouds, and to give freer play to the yards and sails when braced far on either tack.

Harpocrates. The Græcised name of the Egyptian god Har-pi-chruti, i.e. (according to Bunsen and Lepsius) Horus the child, represented generally as a naked boy, sitting on a lotus flower, with his finger in his mouth, to denote (not, as is commonly supposed, silence, but) the childish actions of infancy.

Harpsichord. A keyed musical instrument strung with wires like a pianoforte, in which the sounds are produced by means of small vertical sticks, called *jacks*, upon which the keys act as levers. In the jacks are inserted short pieces of quill; these, upon passing the strings, set them in vibration. This instrument is now superseded by the pianoforte.

Harpyia (Gr. Ἅρπυια, *Harpy*). This term has been applied both to a genus of Raptorial birds and to a genus of Lepidopterous insects.

Harrier. A small hound trained for hunting the hare, remarkable for the acuteness of its sense of smell.

Harringtonite. A mineral compound of silica, alumina, lime, soda, and water, from the North of Ireland.

Harrow (Dan. haro). In Agriculture, a rhomboidal frame with a number of spikes inserted in it on one side. This frame, when dragged over ploughed land, breaks the furrow slices into small pieces, for the purpose of preparing the land for seed in some cases, and for covering the seed in others. The spikes are inserted in it, at such distances that when the frame is drawn along in a straight line, the tines, as they are technically termed, pass through every part of the soil traversed by the frame. Finlayson's harrow is an implement of the so-called grubber class, in which the frame is carried on wheels, the teeth being pointed forward so as to take hold of the land. This implement, by means of a long lever, can be regulated to such a nicety as to stir the soil to the depth of only one or two inches, for the purpose of covering grass or clover seeds; or it can be pressed into it so far as to serve, in the case of stubble lands, instead of ploughing. Wilkie's harrow and Kirkwood's harrow can be used for similar purposes; and being on a smaller scale can be worked with fewer horses than Finlayson's, which commonly requires four or six.

Harrowing. The process of drawing a harrow over the soil for the purpose of reducing it to a level, of covering seed, or of turning up weeds in ploughed ground, or moss in grass lands. In agriculture the harrow is drawn by horses; and in market-gardening, where a light harrow is sometimes used, by men. In either case the more rapid the motion of the harrow, up to a certain point, the more efficient will be its operation. For meadow lands, the object of harrowing is to disperse the little heaps of earth raised during winter and early spring by moles and worms. For this purpose the harrows in some parts of the country are turned upside down; while in others, as in Middlesex, thorn branches are tucked into a frame resembling a harrow, and dragged over the surface for the purpose of effecting the same object. This is called a *bush harrow*. A chain harrow is also used for the same purpose.

Hart. [Deer.]

Hartshorn, Spirit of. An impure solution of carbonate of ammonia, obtained by the destructive distillation of hart's horn or any kind of horn or bone. An impure solid carbonate of ammonia, called *salt of hartshorn*, is formed at the same time.

Haruspices. [Aruspices.]

Harvest Bug. [Cimex.]

Harvesting. The operation of pulling, cutting, rooting up, or gathering field crops, and drying or otherwise preparing them for being stored for winter use. The first harvest which occurs in Britain and similar climates is that of the forage grasses, or other plants made into hay; the next is the harvest of cereal grasses, or of corn crops; and the third the potato harvest, or harvest of root crops, such as potatoes, carrots, turnips, mangold wurzel, &c. There is also the harvest of occasional crops; such as that of rape-seed, turnip-seed, dyer's wood, hemp, flax, and various other articles.

Haschisch or **Hasheesh.** The Arabic name for Indian hemp, used as a stimulant in Eastern countries. The Assassins were said to nerve themselves for their horrible work by the excitement which it produced; hence their name. [Assassins.]

Hastati (Lat. from hasta, *a spear*). One of the three grand divisions of the Roman infantry, so called because they were armed with spears. It consisted of young men in the flower of life, who were always drawn up in the first line of battle. The other two divisions were called Principes and Triarii; to which was added another, called Velites, or *light* troops, first employed, according to Livy (xxvi. 4) at the siege of Capua, B.C. 211.

Hastings Sands. The lower member of the Wealden group of deposits, developed in the south-eastern counties of Kent and Sussex. The lower beds are the friable sands of which Hastings Cliff is formed, and these are based on beds of shelly limestone and grit, alternating with some clays. Harder beds yielding good building stone overlie these, and above them are the Tilgate beds of calcareous grit, extensively quarried in Tilgate Forest near Horsham. The rocks at Tunbridge Wells and other places are very picturesque portions of the Hastings sand. Beds of ironstone were formerly worked in this deposit.

Hat (Ger. hut). What is usually called a *beaver* hat is made of a variety of furs, chiefly those of the hare and rabbit, mingled with wool, and in the best hats a proportion of beaver's fur; but the latter is altogether omitted in common *stuff* hats. The furs are mixed; the long hair is picked out; and they are then placed on a hurdle, which is shaken and made to vibrate by being struck with a bow-string; in this way the dust is shaken out, and the fibres are to a certain extent interwoven. [Felt.] A quantity of this mass of fur sufficient for one hat is called a *bat* or *capade* (Ure's *Dictionary*, art. 'Hat-making'): it is pressed, kneaded, and at length moulded so as to form a kind of conical cap, the irregularities or small fibres of the different furs entangling with each other so as to keep the whole adherent. The cap is then dipped into warm water acidulated by sulphuric

acid, and wrought for several hours by the hands, by which it is thickened or fulled; the knots are picked out of it, fresh felt here and there added, and the beaver ultimately applied; the hat is then shaped, waterproofed by a lac varnish, tied upon a block, dyed, stiffened by the application of a solution of glue, steamed, brushed, and ironed; the brim is then trimmed, and it is ready for lining and binding.

Silk hats have a foundation of woollen felt, upon which a silk plush is afterwards applied.

Hatch (connected by Mr. Wedgwood with Dutch heck, *a barrier of lath*, and Swed. häeck, *a hedge*, which last would also seem to be another form of the same word). The covering of a hatchway. In very bad weather the hatches are battened down, to keep the water which comes in upon the decks from getting below.

Hatchettine. A fusible wax-like substance, found occasionally in nodules of ironstone, named after Mr. Hatchett. It is usually placed by mineralogists amongst bitumens.

Hatchment. In Heraldry. [ACHIEVEMENT.]

Hatchway. A large opening in a ship's deck for communicating with the decks below, the hold, &c.; there are the fore, main, and after hatchways.

Hattemists. An ecclesiastical sect in Holland, so called from Pontian von Hattem, a minister in Zealand: nearly allied to the Verschorists. They arose in the latter part of the seventeenth century. They appear to have denied the *expiatory* sacrifice of Christ. It is added, that they denied the corruption of human nature, and the difference between moral good and evil.

Hatti-scheriff. An edict signed by the hand of the Sultan is so named in Turkey.

Hauberk (Old Ger. halsberge, A.-Sax. healsborg, from heals, *the neck*, and beorgan, *to cover*). A piece of armour, supposed to be of German origin, common in the chain mail, or rather ringed mail, of the twelfth century; being a jacket or tunic, with wide sleeves reaching a little below the elbow, the hood being of one piece with it. The hauberk of ringed mail ceased to be worn about the reign of Henry III., when the Oriental chain mail, properly so called, came into fashion for a short period.

In France only persons possessed of a certain estate, called *un fief de hauber*, were permitted to wear a hauberk, which was the armour of a knight; esquires wore only a simple coat of mail, without the hood and hose.

Haugh. A Scotch term, applied to lands which in England would be called *meadow* or *pasture*.

Haul. The Sea term for pulling upon a rope directly.—*To haul the wind*, to bring the ship to sail close by the wind after running in some other direction.

Haunches (Old High Ger. hlancha, Fr. hanche). In Architecture and Engineering, the word *haunches* is used to express the filling in of the masonry required to make up the horizontal line of the structure, between the voussoirs of the arches and the line of the string, which is generally introduced over the whole series. The haunches are, in fact, the horizontal filling introduced to complete the structure; and the radiating joints in the haunches of the old Westminster Bridge have always been regarded as both a theoretical and practical defect in that building. The purpose of the haunches is to bring down the pressure of the roadway, or of the superstructure, upon the arches, and this is done in the most effectual manner by directing the line of thrust normally to the arch; in some of Smeaton's and of the early Roman bridges, however, the haunches of the great arches are often lightened by the introduction of a small circular arch, which is formed in the masonry of the upper structure. Examples of this method of lightening the haunches of mediæval arches are found in Wells and Salisbury Cathedrals.

Haurient. In Heraldry, a term applied to a fish placed in pale, and having its head in chief, as if rising to the surface for air.

Hausmannite. Native oxide of manganese; so called in honour of Prof. Hausmann.

Haustellata (Lat. haurio, *I draw forth*). A name of a grand section of insects, including all those which in the perfect state have the oral apparatus adapted for suction.

Hautbois. [OBOE.]

Haüyne. A blue mineral in small granular or spherical masses, generally found in basalt or lava. Named after Haüy, the celebrated French mineralogist.

Haven (Ger. hafen). [HARBOUR.]

Haversack (Fr. havre-sac). A strong coarse linen bag for carrying provisions on a march.

Hawk. [FALCO.]

Hawk-moth. [SPHINX.]

Hawkers, Pedlars, Petty Chapmen. In Law, persons travelling from town to town with goods and merchandise for the purpose of sale. They are required to take out licenses under 50 Geo. III. c. 41. Wholesale traders are exempt from the provisions of this Act, as are also licensed auctioneers going from town to town.

Hawking. [FALCONRY.]

Hawse (A.-Sax. hals, *the neck*). The portion of sea immediately in front of a ship's bows, and extending from an imaginary line rising from her anchors. The cables pass through the *hawse holes*, which are made in the timbers and in the *hawse piece* outside. When the ship has two anchors down, and the cables diverge from each other, the hawse is said to be *clear*; when crossed by the ship turning half round, there is a *cross* in the hawse. Another cross makes an *elbow*; then a *round turn*: in the last two cases the hawse is said to be *foul*. The process of disengaging the cables is called *clearing hawse*. The danger of a foul hawse is, that if it comes on to blow, the cables cannot be veered from their friction against each other.

Freshening hawse is veering out a little cable to expose a new surface to the friction in the hawse hole, or across the cutwater.

Athwart hawse implies across the bows of a vessel at anchor.

Hawthorn. One of the common names of *Cratægus Oxyacantha*, the Whitethorn, May, Maybush, Quick, and Quickset of the rustics. It is one of the most beautiful of our small trees, and also one of the most useful, being everywhere employed as a most efficient live fence. Many improved varieties are cultivated in our shrubberies and demesnes, as the Scarlet, the Double Scarlet, the Double White, &c. The Glastonbury Thorn, another variety, begins to blow very early, so that in mild seasons it is occasionally met with in blossom at Christmas. In reference to the name Hawthorn, i.e. the Thorn of haws, heys or hedges (A.-Sax. hagathorn, hægthorn or hegethorn), Dr. Prior remarks that it is interesting as affording testimony to the use of hedges and the appropriations of flats of land, from a very early period in the history of the Germanic races. The term *haw*, he continues, is incorrectly applied to the fruit of this tree in the expression *hips and haws*, the latter word denoting really the fence on which it grows. Many other species of *Cratægus* are cultivated for ornamental purposes, and to these the general name of Thorn is also applied.

Haymaking. The operation of cutting down, drying, and preparing grasses and other forage plants for being stacked for winter use. The plants are mown down at the time when they are supposed to contain a maximum of nutritious juices, viz. when they are in full flower. Dry weather, and if possible that in which sunshine prevails, is chosen for this operation; and the mown material is spread out and turned over two or three times in the course of the same day in which it is cut. In the evening it is put into small heaps. In the morning of the second day these heaps are spread out, and turned over two or three times; and in the evening they are formed into heaps somewhat larger than they were the day before. If the weather has been remarkably warm and dry, these heaps in the course of the third day are carted away and made into a stack; but if the weather has been indifferent, the process of opening out the heaps and exposing them to the sun is repeated on the third day, and stack-making is not commenced till the fourth. The grand object in making hay is to preserve the colour and natural juices of the herbage, which is best done by continually turning it so as never to expose the same surface for any length of time to the direct influence of the sun. In stacking the hay the object is to preserve this green colour, and at the same time induce a slight degree of fermentation, which has the effect of rendering the fibres of the plants composing the hay more tender, and changing a part of the parenchymous matter into sugar. This sweet taste renders the hay more palatable to horses. The best directions for haymaking will be found in Middleton's *Agricultural Survey of Middlesex*.

Hayward (A.-Sax. haga, Fr. haie, *hedge*). An officer anciently appointed in the lord's court to take care of the cattle of a manor, and prevent them from injuring the hedges or fences.

Hazel (A.-Sax. hæsl or hæsel). The common name of the Nut (*Corylus*), a deciduous shrub or low tree, commonly found in hedgerows and as undergrowth in woods. The fruit is well known for its use at dessert; but it is not the wild form *C. Avellana* which is usually so employed, but improved varieties, to which the names of Filberts and Cobnuts are applied. Nuts if dried in the sun, and thus thoroughly harvested, may be kept for use, in closed vessels or small casks, till the following spring. The chief thing to be guarded against is mouldiness arising from moisture retained in the husks. Common nuts, as imported, without the husks are of course much less liable to this inconvenience.

Head. The fore extremity of a ship. It generally means the cutwater, which is adorned with a figure. *By the head*, implies that the ship's head is depressed in the water. *Head sails, head yards*, are the sails and yards in the fore part of the ship.

Head of Water. The height which a column of water is submitted to is called in Engineering *the head*; it is measured from the upper surface of the lower stream to the upper surface of the reservoir producing the pressure; the effective pressure will be that indicated by this height diminished by the friction that the column of water undergoes in the pipes, and through any change of direction that may take place in them.

Headache. This is a common symptom in various diseases: it frequently occurs both in full and in debilitated habits, and also in persons who are otherwise healthy. One form of headache consists in a degree of torpor and of confusion, with a dull pain over the whole head, dimness of sight, and inability to attend to anything requiring thought or fixed attention. Sometimes it is referable to disordered stomach or bowels, but it also comes on without any such assignable cause. These headaches are relieved by nervous stimulants, such especially as camphor, ether, and ammonia. A cup of strong coffee or of green tea often acts like a charm; and if the pain prevents rest, a small dose of opium is sometimes necessary, with perfect rest and quiet. Some very troublesome cases are relieved by cold applications to the temples and the head, others by snuff and nasal stimulants. There is a peculiar form of headache which consists of throbbing and pain of one particular part, or sometimes over one side of the head; it lasts an hour or two and then goes off, and returns again at stated intervals. This is called *hemicrania* (the *migraine* of French, and the *megrim* of old English writers), and is often of a distinctly intermittent character. For its permanent cure bark or sulphate of quinia are in use; blisters behind the ears are also of service. In bilious or sick headache, emetics and purges are required.

Obstinate headaches are not unfrequently got rid of by change of air, scene, and occupation; especially where they are the result of excessive intellectual application.

Headborough (Sax. borg, *pledge*). The chief of the ten *pledges* in frankpledge [FRANKPLEDGE]; also styled *borsholder*, *tything-man*, &c.

Headers. In Architecture, bricks, or stones, laid with their heads, or short faces, in front, and their long faces in the body of the work.

Heading Courses. In Architecture, the horizontal courses, which consist entirely of headers, in opposition to stretchers, or stretching courses. [BOND, ENGLISH.]

Headland. In Geography, a term nearly synonymous with CAPE, MULL, NESS, or PROMONTORY [which see].

Headland or **Head Ridge.** In Agriculture, a ridge or border, commonly ten or twelve feet broad, which is continued round a field in some cases, and which in others is only formed at the two opposite sides, for the purpose of affording space for the horses to turn on while ploughing.

Headline. In Printing, the top line of a page in which the running title and folio are given. The divisions and subdivisions of a work, when they are set in lines, and chapters, are also called *heads*.

Headpieces. In Printing, ornaments placed at the top of the first page and of the pages beginning with books, chapters, &c., and which are therefore called *headpages*. The headpieces of the old MSS. and some of the early printed books were beautifully illuminated; but in course of time wood engravings, cast metal ornaments, flowers, and brass rules were made available for working with the types. Headpieces have been revived of late years; they are mostly copied from old works, but engraved in a finer style.

Headstock. In Machinery, the framing used for supporting the gudgeons of a wheel.

Healds. The harness for guiding the warp threads in a loom.

Healfang or **Halsfang** (A.-Sax. *a catching of the neck*). The old English name for the punishment of the pillory. The word was also applied to the fine paid in order to commute this punishment.

Hearing Trumpet. An instrument for concentrating sound, and conveying it to the ear. It is generally a short bent tube, wide at the one end where the sound enters, and narrow at the other where the ear is applied. The principle on which it acts is the reflection of sound at an angle equal to that at which it strikes a smooth surface; and accordingly the form of the instrument ought to be so regulated that the whole of the vibrations shall be collected into a focus at the smaller end. But it is not necessary that the form which theory points out should be very accurately observed; the principal advantage is gained by confining the advancing sound by a continual reflection, and preventing it from spreading laterally and being dissipated.

Heart (Ger. herz, a word running through many languages of the Aryan family). The human heart is a hollow muscular organ of a somewhat conical shape, the broad part of which is called its *base*, and the smaller end its *apex*. Its base is placed upon the right of the bodies of the vertebræ, and its apex obliquely to the sixth rib on the left. Internally it is divided into a *right and left ventricle*; the former anterior, and the latter almost posterior, in consequence of the oblique manner in which it is placed. Its inferior surface rests upon the diaphragm. Attached to the base of the heart are two *auricles*, so called from their resemblance to the ear of an animal: they are muscular sacs. In the right auricle are four apertures; two of the venæ cavæ, one of the coronary vein, and one an opening into the right ventricle. In the left auricle there are five apertures; namely, one into the left ventricle, and those of the four pulmonary veins. Each ventricle has two orifices; one from the auricle by which the blood enters, and another into the artery by which it passes out. They are supplied with valves; those at the arterial openings being called, from their form, *semilunar valves*; those at the orifice of the right auricle *tricuspid*, and those at the orifice of the left auricle *mitral*. The valve at the termination of the vena cava inferior, just within the auricle, is called the *valve of Eustachius*. The cavities are lined with a strong smooth membrane. The *pulmonary artery* arises from the right ventricle, and conveys venous blood to the lungs, where having been changed into arterial blood by the action of the air, it returns by the *pulmonary veins*, which terminate in the left auricle; the venæ cavæ, which bring back the mass of venous blood from all parts of the body, terminating in the right auricle. The circle, therefore, which the blood takes is this: It is returned from the various parts of the body by the venæ cavæ into the right auricle, whence it is forced into the right ventricle, and then through the lungs; whence it returns into the left auricle, and from it into the left ventricle; and thence, by the aorta, through the general arterial circulation. The substance of the heart is supplied by nerves and vessels of its own, which are called *coronary vessels*; the coronary arteries branch off from the aorta, and the coronary veins return their blood into the right auricle. The nerves are branches of the eighth and great intercostal pairs.

Heart Wheel. The name given to a well-known mechanical contrivance for converting a circular motion into an alternating rectilinear one, which is generally adopted in the machinery of cotton mills. It consists of an ellipse turned either on an axle, or by means of a winch and handle in one of its foci, or its centre, on whose edge a movable point or circle presses; the latter receives an alternating motion from the circumference of the ellipse, which in its motion presses it to different distances from the centre of motion. The practical disad-

vantages of this contrivance are, the inequality of pressure and of moving force which will be required at different parts of the rotation of the ellipse, and the consequent wearing of some parts of it before the remainder.

Heart Wood. In Botany, the English term for *duramen*. It is the central part of the trunk of a tree hardened by the deposition in its tissue of various secretions, which clog up the passages, and forbid the passage of anything through them.

Hearth (A.-Sax. heorth, another form of *earth*). The part of a furnace where the metal accumulates, and where it is finally separated from the impurities that may be present in the ores; it is situated at the bottom of the furnace a little above the mouth and the tuyeres. The term is also applied to part of an open furnace, where the metal is exposed to the action of fire.

Heartsease. [VIOLA.]

Heat (Ger. hitze). This term has been applied both to the sensation experienced on touching a hot body, and to the cause of that sensation: in the latter sense it is synonymous with the term *caloric*. The escape of heat through space is called the *radiation* of heat, and its communication by contact *conduction*. The term *specific heat* is applied to the quantity of thermometric heat required to raise equal weights of different substances to the same temperature. Thus, experiments prove that the quantity of heat which will raise olive oil two degrees will only raise water one degree; hence a pound of water at 212° may be said to contain twice as much heat, or to have twice the capacity for heat that belongs to oil: or the specific heat of water being =1, that of oil is 0·5. When heat changes the state or form of bodies a large quantity disappears, and remains in them so long as they retain one form. To heat in this state of combination, and inappreciable by the thermometer, the term *latent heat* or *caloric of fluidity* has been applied. [EVAPORATION; EXPANSION; LIGHT; RADIANT HEAT; THERMOMETER; THERMOTICS.]

Heat, Dynamical Theory of. Two theories have been propounded to account for the phenomena of heat: *the material theory*, and *the dynamical or mechanical theory*. The material theory supposes heat to be a kind of subtle and imponderable matter, capable of being combined with ponderable matter and again separated from the latter. The dynamical theory assumes heat to be, not a peculiar kind of matter, but a peculiar motion of the ultimate particles of matter. It is well known that, by the rapid blows of a sledge-hammer, a piece of iron may be rendered almost red hot. The material theory would here account for its developement, by assuming that the compression of the iron by the blows of the sledge had squeezed out, as it were, a quantity of the heat which previously existed in the interatomic spaces of the metal. The dynamical theory, however, maintains that the mechanical motion of the hammer, which is stopped or destroyed when it falls upon the iron, is converted into a motion of the ultimate particles, both of the sledge and of the iron upon which it falls: in fact, the motion of the hammer as a mass is transferred to the individual atoms of the hammer and of the piece of iron, and this atomic or molecular motion thus acquired constitutes heat. The limits of this article will not admit of the introduction of the experiments and reasoning by which the dynamical theory of heat has gradually but completely driven its rival from the field. For a masterly exposition of this and the whole subject of heat, the reader is referred to Tyndall's *Heat considered as a Mode of Motion*.

Heat Rays. This term is usually applied to the red rays of the spectrum, and to other rays which fall outside the red end of the spectrum, and which are consequently invisible. The modern theories of heat and light will not, however, permit of the conception that there can exist any ray of light, which, when absorbed, will not raise the temperature of the surface absorbing it; and therefore the division of the rays of the spectrum into heat rays and light rays is no longer strictly philosophical. It is, however, certain that those rays which produce the greatest heating effect and but little luminous effect are concentrated about the least refrangible end of the spectrum, while the most luminous rays are more refrangible, and are consequently thrown nearer to the violet extremity of the spectrum.

Heath or **Heather** (A.-Sax. hæth, Ger. heide). In a general sense the term *heath* is applied to waste land in which the prevailing plants consist of one or more of the common species of heath, especially *Calluna vulgaris*, the *Erica vulgaris* of Linnæus. This plant covers many hundreds of acres in the Highlands of Scotland, in Ireland, and in similar climates on the Continent. It attains, in many places, the height of three or four feet; and is used for thatching houses, making besoms, and for a variety of other purposes. The tender tops form a substitute for mattresses in Highland cottages; and they are also eaten green and in a dried state by horses, cattle, and sheep, in countries where the grasses and clovers do not begin to grow till late in the spring. Other common species are *Erica Tetralix* and *E. cinerea*.

Heave (A.-Sax. hebban, Ger. heben). In Nautical phrase, to employ force to move great weights by the lever, &c.; as *to heave up* the anchor by the capstan or windlass; *to heave down* the ship, or pull her over on one side to get at a leak; also *to heave taut* (tight), or turn the capstan till the rope or chain applied to it becomes tight.

Heaven (A.-Sax. heofon). The Celestial Sphere, or Firmament, or Sky, in Astronomy, denotes the spaces in which the celestial bodies are placed, or through which they apparently perform their diurnal revolutions. The term *heaven* was frequently used by the ancients to denote the orb or sphere in which a celestial body appears to move; and hence the ancient astronomers assumed the existence of as many

heavens as they observed different and apparently independent motions. They supposed the various heavens to be solid, because they could not otherwise sustain the bodies placed in them; and spherical, because perfect motion must be performed in a circle which is formed by the section of a sphere; and crystalline, because the different bodies are visible, though their orbs include one another. The first heaven was that of the Moon, the second of Venus, the third of Mercury, the fourth of the Sun, the fifth of Mars, the sixth of Jupiter, and the seventh of Saturn. The eighth, which is that of the fixed stars, was called particularly the *firmament*. Ptolemy added a ninth, which was the *Primum Mobile*. All these reveries have been exploded by the discovery of the true system of the universe, and the laws of the planetary motions.

Heavy Spar. Native sulphate of baryta. This is a common mineral in many mining districts. It occurs in several crystalline forms, of which the cleavage is a right rhomboidal prism; it also occurs fibrous, radiated, and stalactitic. Some beautiful specimens of the latter variety have been found in Derbyshire of a brown colour. The crystals are usually white, or nearly colourless. The specific gravity of sulphate of baryta is 4·1 to 4·6. It consists of 77 baryta, 40 sulphuric acid, its equivalent being 117. It enters into the composition of some kinds of pottery, but it is chiefly used in the adulteration of white lead. [BARIUM.]

Hebdomadal Council. [CONGREGATION; CONVOCATION, HOUSE OF.]

Hebe (Gr. Ἥβη). In Grecian Mythology, the goddess of youth, whose office it was to hand round the nectar at the banquets of the gods. She answers to the Latin goddess Juventas.

Hebrew Language. A dialect of the Semitic family of languages. The books of the Old Testament are preserved to us in this language, which was most closely allied with that of the Phœnicians, Canaanites, and Carthaginians.

Hecate (Gr. Ἑκάτη). In Mythology, a goddess, not mentioned in Homer, but by later writers spoken of as a daughter of Perses and Asteriê. Her name is the feminine form of Hecatos (the Far-shooter), applied to Phœbus, Apollo, and Helios (the Sun). In the Homeric Hymn, she aids Demeter (Ceres) in her search for Persephonê (Proserpine); in other versions of the myth she remained with the latter in the nether world. Statues were set up to her in market-places, and especially at cross-roads.

Hecatomb (Gr. ἑκατόμβη). Properly, a sacrifice of a hundred oxen; but the word is often used to signify a large sacrifice of any kind of victims.

Hecatos. [HECATE.]

Heckle. An instrument used in separating the fibres of flax and placing them in parallel tresses.

Hectic Fever (Gr. ἑκτικός, from ἕξις, *habit*). A constitutional fever, attended by debility, a small quick pulse, paleness, loss of appetite, excessive perspiration, and emaciation. It generally affects more or less of an intermittent character; but the exacerbations and remissions are irregular, and the sweating stage is not followed by that relief which it usually announces in other febrile attacks. It is often symptomatic of some particular disease, and requires to be treated accordingly. Where this is not the case, or where it seems merely an attendant on general debility, a course of sarsaparilla and a milk diet are often very beneficial; but where this remedy induces perspiration and nauseates, much management is required in carrying it on for a sufficient length of time to prove of service.

Hectogramme. A French measure of weight = 100 grammes, or 1,543·4 English grains.

Hectolitre. A French measure of volume = 100 litres, or 6,102·8 English cubic inches.

Hectomètre. A French measure of length = 100 mètres, or 3,937 English inches.

Hecuba. In Mythology. [PARIS.]

Hedenbergite. A silicate of lime and iron, first described and analysed by Hedenberg, in Sweden.

Hedera (Lat.). The genus of the Ivy, belonging to the order *Araliaceæ*, and consisting of scandent evergreen shrubs, climbing by means of short sucker-like rootlets, which cling to any surface with which they come in contact. Ivy is thus enabled to mount to the tops of the highest buildings or of the tallest trees. The Common European Ivy, *H. Helix*, yields a large number of varieties. There are other species peculiar to Africa—*H. canariensis*, and to Asia—*H. colchica* or *Rægneriana*, both of them well known in gardens.

Hederic Acid. A crystallisable acid contained in the seeds of the common Ivy (*Hedera Helix*). An alkaloid (*Hederine*) has also been obtained from the same source.

Hedge (A.-Sax. hegge, Fr. haie). A living fence or wall formed of woody plants, sown or planted in a line, and cut or clipped in such a manner as to form a compact mass of any degree of width and height that may be required for the purpose of shelter, separation, or defence. The fences most generally used in agriculture are made of the white thorn (*Cratægus oxyacantha*, Linn.), because it has spiny branches, and forms a strong defence against cattle. Fences for the purposes of shelter and separation are chiefly used in gardening, and for the most part are formed of evergreen shrubs, such as the holly, yew, box, &c.; or sub-evergreens, as the privet; of flowering shrubs, as the *Cydonia japonica*; or of deciduous shrubs or trees with persistent leaves, as the hornbeam and beech. In the management of hedges of every description an important point is to keep them thick, and impervious to wind or to animals near the ground; for which purpose the section of the hedge should be made broader at the base than at the top, in order that the exterior leaves in every part of the hedge may enjoy in an equal degree the influence of light, air, and perpendicular rains.

Hedgehog. [ERINACEUS.]

Hedyphan. An arsenio-phosphate of lead and lime from Sweden.

Hedysarum (Gr. ἡδύς, *sweet*, and ἄρωμα, *a spice*). A genus of herbaceous or dwarf shrubby *Leguminosæ*, several of which are familiar in gardens. To this genus belong the Camel's Thorn, *H. Alhagi*, which produces a manna-like substance; and also the Moving or Windmill plant, *H. gyrans*, whose leaves possess the curious property of moving their leaflets spontaneously in different and opposite directions, under the influence of light and warmth.

Heel. The after extremity of the ship's keel: also the foot of a mast.—*To heel over*, is to incline to one side.

Hegel, Philosophy of. [SCHELLING, PHILOSOPHY OF.]

Hegira. In Chronology, the era used by the Mohammedans in the computation of time. The epoch or first day of this celebrated era, so extensively employed in the East, corresponds to Friday, July 16, in the year 622 of the Christian era. It is a problem of some importance to convert dates expressed by the Mohammedan computation into the corresponding dates of our calendar; for effecting this it is necessary to be acquainted with the form of the Mohammedan year.

This year is strictly lunar; and the civil months are adjusted to the lunar months by means of a cycle of 30 years, containing 19 common years of 354 days, and eleven intercalary years of 355 days; the cycle thus containing 10,631 days, or 29 Julian years and 39 days. Each year is divided into 12 months, containing alternately 30 and 29 days, excepting that the last month of the intercalary year contains also 30 days. The intercalary years are the 2nd, 5th, 7th, 10th, 13th, 16th, 18th, 21st, 24th, 26th, and 29th of the cycle. The names of the Mohammedan months, with the number of days in each, are as follow:—

	Days		Days
Moharem . .	30	Shaban . .	29
Saphar . .	29	Ramadan . .	30
Rabiu I. . .	30	Shawall . .	29
Rabiu II. . .	29	Dhu'l Kadah .	30
Jomadhi I. .	30	Dhu'l Hajah .	29
Jomadhi II. .	29	——— in intercalary years .	30
Regeb . .	30		

Such are the chronological elements by means of which Mohammedan dates are reduced to the Christian era. The rule by which the reduction may be accomplished is as follows:—

1. Divide the number of years (of the Hegira) elapsed by 30; the quotient will be the number of cycles, and the remainder the number of years elapsed since the beginning of the current cycle. Call the quotient A, and the remainder B, and let x be the number of intercalary years in B; then the number of days that have elapsed from the commencement of the Hegira to the beginning of the year in which the date occurs is given by this formula:

$$10{,}631\,A + 354\,B + x;$$

for 10,631 is the number of days in the cycle, and 354 the number of days in the common lunar year. To the sum obtained by this formula add the days since the beginning of the current year, and the result is the number of days from the commencement of the Hegira to the given date.

2. To the number of days from the commencement of the Hegira to the given date add the number of days between the commencement of our era and the Hegira, and the sum is the number of days from the first of our era to the given date. The number of days from the beginning of our era to the Hegira, or to July 16, 622, is 227,016.

3. Having now found the number of days from the Incarnation to the given date, it only remains to convert the sum into Julian years. For this purpose divide by 1,461 (the number of days in the Julian intercalary period), and call the quotient C. Divide the remainder by 365, and call the quotient D, and the remainder of this last division y. Then $4\,C + D$ is the number of Julian years elapsed since the beginning of the Christian era, and y is the number of days that have elapsed of the current year. This gives the date in Old Style. To reduce it to the Gregorian Style, it is only necessary (during the present century) to add twelve days. [CALENDAR.]

Height (Ger. hoheit). In Geometry, the same as ALTITUDE [which see].

Heighten (from *height*). In Painting, a verb signifying to make prominent by means of touches of light or brilliant colours, as contrasted with the shadows; the effect is also heightened by deepening the shadows.

Heights, Measurement of. The determination of the relative altitudes of points on the earth's surface is of equal importance in physical geography with the determination of their latitudes and longitudes. There are three different methods by which the operation is usually effected. When it is required to determine not only the height of one point or station relatively to another, but the relative heights of a number of points above a common horizontal plane (as for tracing the line of a canal), recourse is had to the operation of levelling. The second method is to observe the angle of elevation or depression of one station as seen from another, and to compute, from the observation and from the distance of the two stations, the difference of altitude by the rules of trigonometry. The third method, and the most important, as being, generally speaking, the most applicable, is to deduce, by means of the known physical properties of the atmosphere, the differences of vertical height from the observed differences of atmospheric pressure as indicated by the barometer.

The following approximate formula for calculating the difference of altitude z, in feet, between two stations at which h and h' are the heights, in inches, of the mercurial column, is frequently used:

$$z = k\,(\log h - \log ch').$$

In this formula common logarithms are to be employed, and k and c are to be previously determined by the following formulæ, in which

τ and τ' denote the temperatures, centigrade, of the mercury at the two stations, t and t' the temperatures of the air, and l the latitude:

$$k = \frac{60345}{1 - \cdot 00257 \cos 2l}\left(1 + \frac{t + t'}{500}\right),$$

$$c = 1 + \frac{\tau - \tau'}{5550}.$$

The method of obtaining these formulæ is given by Poisson in his *Mécanique*, t. 2. In Biot's *Astronomie Physique*, and Schumacher's *Astronomische Nachrichten*, still more complete investigations on barometric measurements will be found. The most handy method with which we are acquainted is due to Mr. Ellis; it will be found described at length in the *Reader* of July 23, 1864.

Heimia (after Dr. Heim, of Berlin). To this genus of *Lythraceæ* belongs *H. salicifolia*, the Hanchinol of the Mexicans, regarded by them as a potent remedy in venereal diseases. It is a small shrub, with willow-like leaves, and yellow flowers in their axils.

Heir (Lat. hæres). In Law, one who succeeds by descent to lands, tenements, and hereditaments. Strictly speaking, a person is not properly called heir in the lifetime of his ancestor; according to the ancient maxim, *nemo est hæres viventis*. (For the rules which govern this succession in England by common law and statute, see DESCENT.) *Heir-apparent* is he who (by law or custom) must succeed, by descent, to the hereditaments, if he survive the present tenant; as at common law, the eldest son. *Heir-presumptive*, he who stands nearest in succession in the default of an heir-apparent; as an eldest brother where there is no issue. *Heir-at-law*, or *heir-general*, is he who succeeds by descent to lands in fee simple. *Heir-special*, issue in tail claiming by the form of the gift. [FEE TAIL.] *Heir by custom*, he who succeeds to lands or tenements by custom; as all the sons by gavelkind. *Heir-male*, i.e. the nearest male in the succession, is not strictly a term of English law, since lands cannot descend in this way; but some dignities are thus limited. A devisee is sometimes called *heir by devise*, or *hæres factus*. Bastards, aliens, persons attaint of treason and felony, cannot be heirs; but idiots and lunatics may. Things that pass with the land, as conditions and covenants real, goods and chattels annexed to the freehold [FIXTURES], and terms of years to attend the inheritance, are in ordinary legal language said to go to the heir: as also *heir-looms*, being such goods and chattels as go by special custom along with the inheritance. In Scottish law, the word *heir* is taken in a larger acceptation, as to personal as well as real property. Heirs-at-law are termed in it *heirs whatsoever*. Scottish law recognises several species of heirs: as the heir-active, who has the right of action; heir of line, or lineal heir; ceeds to estates to which the donor did not himself succeed by descent; heirs portioners, in English law coparceners; heir of tailzie (or in tail), and so forth. By the civil law, heirs are of two kinds—legitimate, or by act of law; and instituted, or by the will of the possessor: the former only answering to those who are properly designated as heirs in our own law, the latter to our *purchasers*. Legitimate are either *heirs of blood*—heirs under the title *unde vir et uxor*, by which, in default of heirs of blood, a husband or wife succeeded to the goods of the deceased spouse (a provision not generally preserved in modern Continental law); and heirs *irregular*—such as the lord to whom an escheat falls, &c. Heirs instituted are of many kinds.

Heir-looms. In Law, such goods and personal chattels as go to the heir along with the realty. The quality of heir-looms is fixed by custom; but the term is commonly applied to pictures, plate, &c., settled so as to go along with a title or estate.

Helen. In Mythology. [PARIS.]

Heleniне. *Elecampane Camphor*. A crystalline camphor-like substance, found in the root of *Inula Helenium*, or Elecampane. Its vapour has a peculiar odour somewhat resembling that of *patchouli*. Its chemical formula appears from the analyses of Dumas and Gerhardt to be $C_{21}H_{14}O_3$.

Heliacal (Gr. ἡλιακός, *belonging to the sun*). In the ancient Astronomy, a star is said to rise *heliacally* when, after being in conjunction with the sun, and consequently invisible, it rises so soon before the sun as to be visible in the eastern horizon in the morning twilight; and it is said to set *heliacally* when the sun approaches so near to it that it is lost in his light, or ceases to be visible in the western horizon when he has disappeared. At the opposite season of the year the same star rises as the sun sets, and sets as the sun rises; it is then said to rise and set *acronycally*. When a star or planet rises and sets at the same instant with the sun, it is said to rise and set *cosmically*. These technical terms occur frequently in the works of Hesiod, and in Ovid's *Fasti*. The ancients fixed the commencement of the seasons by the positions of the stars relatively to the sun at his rising and setting.

Heliades (Gr.). In Greek Mythology, daughters of the Sun, who wept amber tears on the death of Phaëthon.

Heliæa (Gr. Ἡλιαία, probably connected with ἁλία, *an assembly*, from ἀλής, *thronged*). In Ancient History, the chief of the ten courts among which the 6,000 Athenian jurymen were distributed, and which on important occasions sometimes contained them all. Before this tribunal were brought causes of consequence to the state and individuals, which did not involve bloodshed. (*Mém. de l'Acad. des Inscrip.* vol. xviii.; Boeckh's *Public Economy of Athens*.)

Helianthus (Gr. ἥλιος, *the sun*, and ἄνθος, *a flower*). This genus of *Compositæ* yields the well-known Sunflower, *H. annuus*, one of the most showy of large growing annuals; its seeds yield a useful oil in great abundance. Another species is the Jerusalem Artichoke, *H. tuberosus*, a wholesome esculent resembling the potato, and extensively cultivated.

Helichrysum (Gr. ἥλιος, and χρυσός, *gold*). The typical genus of the race of Composite flowers which are called Everlastings or Immortelles. These 'everlasting flowers' are in fact the flower-heads of the species of *Helichrysum* and of plants allied to it, which at one time or other have been separated. The ornamental part consists of the involucral scales, which in addition to their dry scarious durable character have acquired colours of more or less brilliancy. The common *H. bracteatum* of gardens has given rise to various everlastings of distinct and showy colours.

Helicoid (Gr. ἑλικοειδής, from ἕλιξ, *a curl*). There are two surfaces of this name: the *Developable Helicoid* or *screw-surface*, whose generators are the tangents to a common helix; and the *Skew Helicoid*, generated by a line which moves so as always to rest on the helix and cut its axis perpendicularly. The former is simply the developable osculatrix of the helix—a developable surface, therefore, of which the helix is the cuspidal edge; the latter is a conoid having the helix for its directing curve; it is in fact the locus of the principal normals of the helix. The developable helicoid is circumscribed to the skew helicoid, the helix itself being the curve of contact. Every plane perpendicular to the axis of the helix cuts the developable helicoid in the involute of the circular section of the cylinder on which that helix is traced. The developable helicoid is also the *cyclifying surface* of the helix; that is to say, when the surface is unfolded into a plane, the helix becomes a circle.

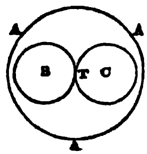
Heliocentric (Gr. ἥλιος, and κέντρον, *centre*). The *heliocentric longitude* of a planet is the angle at the sun's centre, formed by the projection of its radius vector on the ecliptic and the straight line drawn from the centre of the sun to the first point of Aries. Similarly the *heliocentric latitude* of a planet is the angle formed by the straight line which joins the centres of both planet and sun, with the plane of the ecliptic. The greatest heliocentric latitude is consequently equal to the inclination of the planet's orbit.

Heliocentric System. In Astronomy, the system which regards the sun as the centre of our solar system. This theory was first propounded by Aristarchus of Samos, and afterwards established by Copernicus. As put forth by him, it needed only Newton's hypothesis of gravitation to complete the system of modern astronomy. (Sir G. C. Lewis, *Astronomy of the Ancients*, chap. iii.)

Heliograph. An instrument devised by Mr. Warren de la Rue for the special object of obtaining photographs of the sun. It may be described as an equatorial telescope with special modifications. The classic heliograph in use at Kew has a tube square in section and larger at the lower end than at the object glass end. The image of the sun, 0·466 inches in diameter at the focus, is enlarged to nearly four inches by means of a secondary object-glass, and this image is received on a photographic plate. The sun's light is so intense that not only has the aperture to be cut down to two inches, but an instantaneous apparatus of a peculiar construction has to be employed. When the picture is about to be taken, an opening about one-thirtieth of an inch wide flashes across the axis of the secondary object-glass, and the rays from the different parts of the disc pass through it in succession and are depicted on the collodion plate.

Heliography (Gr. ἥλιος, and γράφω, *I describe*). A general name given to the art of fixing images of objects by means of PHOTOGRAPHY [which see].

Heliometer (Gr. ἥλιος, and μέτρον, *measure*). A kind of micrometer for measuring the diameters of the sun, moon, and planets, or any small apparent distance between celestial objects. The instrument best known by this name appears to have been proposed or suggested by Mr. Savery (*Phil. Trans.* vol. xlviii.) about the year 1743; but it was first applied by Bouguer in 1747, and has since been improved by Dollond and Fraunhofer. The principle on which the instrument is constructed is as follows: Two object-glasses of the same focal distance, or rather the two halves of a divided object-glass, are placed side by side in the same tube with an apparatus so contrived that the distance between the centres can be increased or diminished at pleasure. In this manner two images of the sun are formed at the focus of the common eye-glass. Thus the circle A A A represents the field of view of the telescope, or the visible circle at the common focus of the two object-glasses and the eye-glass, while the two small circles represent the two images of the sun formed by the two object-glasses.



When the observer proposes to measure the diameter of the sun, the two object-glasses are brought by means of a tangent screw to such a distance from each other that the two images touch in a point T, and the distance between the centres of the two object-glasses, estimated in seconds, gives the distance between B and C the centres of the images; that is, the diameter of the sun. The Oxford instrument is the finest specimen of its class in England; it is admirably described in Nichol's *Cyclop. of the Physical Sciences*. The principle has also been applied to the microscope. [MICROMETER.]

Helios. [PHAETHON.]

Helioscope (Gr. ἥλιος, and σκοπέω, *I view*). The name given by Scheiner to an instrument of his own invention for observing the sun without hurting the eye. The ordinary method is to place a disc of coloured glass before the eye-piece of the telescope.

Heliostat. An instrument invented by Gravesande for the purpose of obviating in optical experiments the inconvenience arising from the continual change of direction of the solar rays, by reflecting them in the same straight line.

It is easy to conceive a mechanism by which

this object may be accomplished. Suppose a clock to be placed with its dial parallel to the equator, or the axis of the index hands parallel to the axis of the earth; and suppose a rod connected with the extremity of the hour hand to meet the axis produced and make with it the proper angle; then a mirror fixed perpendicularly to the rod will have the motion required.

For a description of the original instrument, see Gravesande's *Phys. Elementa*; but it has been greatly improved by Chasles, Malus, &c. (*Journal de l'École Polytechnique*, cahier 16; Biot, *Physique Expérimentale*, tom. ii.) This instrument is now extensively used in connection with the SPECTROSCOPE [which see].

Heliotrope (Gr. ἡλιοτρόπιον, a plant which turns to the sun). A garden flower of South American origin, known by its peculiar fragrance, which has acquired for it the name of Cherry-pie. The flower-heads offer a good illustration of branching circinate racemes. It can scarcely be called showy, but the plant is highly valued for its odour. *H. peruvianum* is the most popular of the species.

HELIOTROPE. In Geodesy, an instrument used to reflect light to distant stations. Merz and Professor W. A. Miller have both suggested very convenient forms of this instrument.

Helix (Gr. ἕλιξ, *a whorl*). The name of a Linnæan genus of the *Vermes Testacea*, characterised by the entire and crescent-shaped opening of the shell, and forming in the system of Woodward the type of a family of terrestrial and air-breathing Gastropods, including the genera *Vitrina*, *Bulimus*, *Pupa*, *Succinea*, *Anastoma*, *Streptaxis*, *Sagda*, *Helicella*, *Stenopus*, *Omalonyx*, *Partula*, *Achatina*, *Glandina*, *Spiraxis*, *Achatinella*, *Cylindrella*, *Balea*, *Megaspira*, *Clausilia*, and *Helix* proper, of which our common garden snail, *Helix hortensis*, is an example.

The great vine-snail (*Helix pomatia*, Linn.) formed one of the luxuries of the tables of the ancient Romans, and by peculiar feeding and other treatment was brought to attain an immense size. It is still an article of food in certain cantons in Switzerland and France. Snails do much damage to vegetables in cultivated grounds, biting off pieces of the leaves by means of a semicircular dentated horny plate, which is affixed to the upper lip.

HELIX. In Anatomy, this term is applied to the reflected margin of the external ear.

HELIX. In Architecture, the curling stalks, or volutes, under the flowers in each face of the abacus of the Corinthian capital.

HELIX. In Geometry, a non-plane curve whose tangents are all equally inclined to a fixed right line. The tangents to a helix, therefore, are parallel to the generators of a right cone, having this fixed line for axis. The osculating planes of a helix are also equally inclined to this fixed line, since each contains two consecutive tangents, and is therefore parallel to a tangent plane of the above right cone. The binormals and their parallels, the polar lines of a helix being perpendicular to the osculating planes, are parallel to the generators of the reciprocal of the auxiliary cone under consideration, which reciprocal is obviously also a right cone, so that the polar lines of the primitive helix are inclined to the fixed line at a constant angle, which is the complement of the inclination, to the same line, of the tangents to the original helix. These polar lines, therefore, are tangents to a second helix; in other words, the polar surface of a helix is itself a developable helicoid; the cuspidal edge of this surface, that is to say the second helix itself, is of course the locus of the centres of the osculating spheres of the first helix. The principal normals of a helix are obviously perpendicular to two corresponding generators of our reciprocal cones, and therefore to the plane of these generators, which latter contains the common axis of the cones. Hence the principal normals in question are all perpendicular to the fixed line, in other words parallel to a fixed plane.

The rectifying planes of a helix, being perpendicular to the principal normals, are parallel to the fixed line, and therefore the rectifying surface which they envelope is a cylinder, whose generators, the rectifying lines, are also parallel to that fixed line. When this rectifying surface is an ordinary cylinder of rotation, the helix becomes the *common helix*, or the curve formed by the thread of an ordinary screw. For the general helix the ratio of the angles $d\tau$ and $d\sigma$ of contact and torsion, and hence also the ratio of the radii ρ and r of curvature and torsion, are constant. This is evident on reflecting that $d\tau$ and $d\sigma$ are the angles between corresponding consecutive generators of our auxiliary reciprocal cones. Conversely the curve is a helix for which $\frac{r}{\rho}$ is constant. This was first shown by Bertrand (Liouville's *Journal*, 1848). For the common helix both ρ and r are constant—a theorem whose converse is also true, as has been shown by Puiseux. The radius of curvature ρ, in fact, is then simply the radius of curvature at the extremity of the minor axis of the elliptical section, in which the right cylinder is cut by the osculating plane; and since all osculating planes are equally inclined to the axis of the cylinder, all such ellipses are equal. The principal normals of the common helix all pass through its axis, and therefore generate a conoidal surface, the skew helicoid, upon which the axis is a line of striction. The locus of the centres of absolute curvature, which for all non-plane curves is situated on the polar developable, coincides with the cuspidal edge of the latter surface in the case of a common helix; so that the loci of centres of absolute and spherical curvature of the helix coincide with a co-axal helix, which has, in common with the original, the same principal normals. The two helices are consequently curves on the same skew helicoid, formed by their common principal normals.

Amongst the numerous interesting properties

of two such *conjugate helices*, the following are worth noting: The tangents of one helix are the polar lines of the other, that is to say the developable osculatrix (*helicoid*) of the one is the polar developable of the other, or the osculating plane of the one is the polar plane of the other; so that their elements adjacent to a common principal normal are perpendicular to one another. These two helices are but special cases of curves described upon the same skew surface, so as to have in common the generators of this surface for principal normals. Two such curves always intercept equal segments upon all generators, and their corresponding osculating planes, through the same generator, enclose a constant angle. Bertrand, Serret, Voizot, and Curtis have published interesting papers on this subject in Liouville's *Journal*, vols. xv. and xvi.

The common helix which passes through three consecutive points of a non-plane curve, and has its axis parallel to the rectifying line of that curve, is called the *osculating helix* of the latter. [OSCULATING HELIX.]

(Gr. Ἑλλάς, *Greece*, and ..., *beast*). A fossil mammalian discovered by M. Gaudry near Pikermi, in Greece. Its similarity to the giraffe at first led Professor Duvernoy to place it under the genus *Camelopardalis*, which it resembled in the proportions of the lower jaw, in the secondary modifications of the grinding teeth, and in the length of the limbs. It was, however, devoid of horns. M. Gaudry and Professor Owen, therefore, erected it into a separate genus. It is found in the old pliocene of France and Greece.

Hellanodicae (Gr. Ἑλλανοδίκαι). The judges in the Olympic games. The judges of the court-martial in the Lacedæmonian army were also known by the same name.

Hellê (Gr.). In Greek Mythology, a daughter of Athamas and sister of Phrixus. She fell from the golden-fleeced ram, and was drowned in the strait which, according to the legend, thus received the name of the Hellespont.

Hellebore (Gr. ἐλλέβορος). In Pharmacy, this term is applied to the roots of the black and white hellebore. The root of Black Hellebore (*Helleborus officinalis*), called also *Melampodium*, has a bitterish acrid taste, and is a drastic purge and emetic: the root of the White Hellebore (*Veratrum album*) is similar, but more active in its operation. [VERATRIA.] It was formerly used in the cure of gout, and in some maniacal cases where no effect is produced except by very powerful means; but these remedies have now fallen into disuse. The leaves of the *Helleborus fœtidus*, or Stinking Hellebore, have also been used to evacuate worms from the intestines; but they are dangerously active.

Helleborus (Gr. ἐλλέβορος). Of the Hellebore genus, one of the *Ranunculaceæ*, *H. niger*, well known in gardens as the Christmas Rose and used in medicine, and the Black Hellebore of the ancients, *H. officinalis*, are the most important species. Several others are objects of interest in gardens on account of the beauty of their flowers. [HELLEBORE.]

Hellenic (Gr. ἑλληνικός, from Ἕλλην, *a Greek*). The name given to the common dialect which prevailed very generally among the Greek writers after the time of Alexander. It was formed, with very slight variations, from the pure Attic of the age preceding its introduction.

Hellenistic. The name given to that dialect of the Grecian language which was used by the Jewish writers. Its peculiarities consisted in the introduction of foreign words very little disguised, but more especially of Oriental metaphors and idioms; but not at all in the inflexions of words, which were the same as in the Hellenic.

Hellenists. The Jews who from their foreign birth or travel used the Greek (Hellenic) language, are distinguished by this name in the Acts of the Apostles. The word is derived, according to a common method of formation in the Greek language, from the verb ἑλληνίζειν, *to Hellenise*, or adopt the manners of a Greek. There were great numbers of Jews scattered throughout the Roman empire at this period, more especially in the Asiatic and East African provinces, where the Greek was the current language. From their long sojourn in foreign countries they were distinguished from the Hebraists, or native Jews, by the greater liberality of their views with respect to the nature of the promises of the Old Testament. It appears from Acts vi. 1, that these Jews retained the distinctive name of Hellenists after their conversion to Christianity, and that there continued to subsist some jealousy between them and the native Christians.

Helm or Helmet (Goth. hilms, Old Norse hialmr, Ger. helm, Fr. heaume). Defensive armour for the head. The armour which particularly guarded the head was known by the general denominations of *headpiece*, *casque*, and *helmet*. Helmets were anciently formed of various materials, but chiefly of skins of beasts, brass, and iron. An open helmet covers only the head, ears, and neck, leaving the face unguarded. Some open helmets have a bar or bars from the forehead to the chin, to guard against the transverse cut of a broadsword; but it affords little defence against the point of a lance or sword. A close helmet entirely covers the head, face, and neck; having on the front perforations for the admission of air, and slits through which the wearer may see the objects around him; this part, which is styled the *visor* (from the French word viser, *to take sight*), lifts up by means of a pivot over each ear. Some helmets have a bever (from the Italian bevere, *to drink*), which, when closed, covers the mouth and chin, and either lifts up by revolving on the same pivots as the visor, or lets down by means of two or more pivots on each side near the jaws. The use of the bever was to enable the wearer to eat and drink more commodiously than could be done in a helmet with a visor only. The helmets of the Greeks

and Romans were mostly open, not unlike skull-caps, as formerly worn by our dragoons. Montfauçon says he never saw an ancient helmet with a visor to raise or let down, although he is of opinion that they had those contrivances. It seems as if the Romans, at least those of which Pompey's army was composed at Pharsalia, had open helmets, as Cæsar directed his soldiers to strike them in the face, which order he would not have given if their faces had been covered. The two Grecian helmets in the British Museum have a kind of contrivance to cover the nose. Over the top of the helmet rose an elevated ridge called the *crest*, representing lions or dragons, &c., to make the warrior appear taller and more terrible. For an admirable description of the helmets and helms in use in Europe at various periods, fully illustrated, see Hewitt's *Ancient Armour and Weapons in Europe.*

Helm (Icelandic, hialmun, perhaps as being the *helve* or handle by which the ship is managed). The mechanism of the steerage, comprising three distinct portions, the rudder, the tiller, and the wheel; though in small craft the last item is commonly wanting. To put the helm *a-starboard,* is to put the tiller over to the right side; *a-port,* to the left side; *up,* to the weather side; *down,* to the lee side.

Helmet or **Helmet Shells.** [Cassis.]

Helminthology (Gr. ἕλμινς, *a worm,* and λόγος). The natural history of worms. [Intestinalia.]

Helmsman. The man who steers. A good helmsman opposes in time the tendency of the ship to deviate from her course by a small motion, which he relaxes as soon as the effect is felt, thus disturbing her sailing as little as possible. A bad helmsman gives her too much helm, and keeps her perpetually yawing from one side to the other. The steering, therefore, is of the utmost consequence in chase.

Helopidæ (Gr. Ἔλοψ, or more properly Ἔλλοψ). A family of Heteromerous Coleopterans, belonging to the section *Stenelytra,* and including numerous subgenera and species. The typical genus *Helops* is remarkable for having the anterior tarsi of the males dilated. Of this genus there are four British species known, of which the *Helops caraboides* may be found at the roots and under the bark of trees: it presents a lengthened ovate form, a brown colour, a punctured surface, and dusky red antennæ and tarsi.

Helots (Gr. εἵλωται). In Ancient History, the slaves of the Spartans, consisting originally, in the opinion of some, of the Achæan inhabitants of Laconia, who were subdued by force of arms by the Dorian invaders. The name was, it is said, derived from Helos, a town of Laconia, of which the inhabitants were thus reduced to servitude. To this class were afterwards added the Messenians, who still clung to their native soil after its subjugation by the Spartans. They were employed either as domestic slaves, cultivators of the land, or in the public works; and though they do not appear to have been treated ordinarily with much severity, yet the recollection of their former state urged them frequently to revolt, while their numbers rendered them so formidable to their masters as to drive the latter to schemes of the most abominable treachery for their repression. (Müller's *Hist. of the Dorians*; Wachsmuth, *Hist. Ant. of the Greeks,* transl. i. 323.)

Helver. A miner's term; the handle of a tool.

Helvine. A mineral occurring in small crystals at Schwartzenberg, in Saxony; it is composed of the silicates of manganese, glucina, and iron.

Helwingiaceæ (Helwingia, the only genus). The characters of this small natural family of Garryal diclinous Exogens lie in their having fasciculate flowers and alternate stipulate leaves. The Japanese use the leaves of *Helwingia ruscifolia* as an esculent.

Hemelytra (Gr. ἡμι, and ἔλυτρον, *a sheath*). The name given to the superior wings or wing-covers of Tetrapterous insects, when they are coriaceous at the base and membranous at the extremity; as in the order *Hemiptera.*

Hemeralopia (Gr. ἡμέρα, *the day,* and ὤψ, *the eye*). A peculiarity in the sight, in which persons see in broad daylight, but not in the evening: it is said to be endemic in some parts of Europe, and of the West Indies. The pupil is generally more dilated and less sensible than in healthy eyes. It has been relieved by tonics and gentle stimulants, with the occasional application of blisters behind the ears.

Hemerobaptists (Gr. ἡμέρα, and βαπτίζω, *I baptise*). An ancient sect among the Jews, so called from washing themselves as a religious solemnity every day. It is thought by some that the Christians of Saint John, or Sabians, descend from them.

Hemerobians (Gr. ἡμέρα, and βίος, *life*). A family of Neuropterous insects, of the section called *Planipennes* by Latreille; characterised by having a slender body, which is greatly exceeded in length by the finely reticulated wings. The ova are deposited in clusters, attached each by a long glutinous pedicle to the leaves of various plants; and by some mycologists have been described as fungi. The larvæ of these insects are remarkable for their ravenous habits; and as they feed chiefly on the plant-lice (*Aphides*), are highly beneficial. They subsist on their juices, suck them to death, and with a singular instinct they clothe themselves with the skins of their victims. Of the typical genus *Hemerobius* there are fourteen known British species, of which the *Hem. perla,* Linn., is the most beautiful. It is sometimes called the *golden-eye*; is of a green colour; the wings transparent, and veined with green.

Hemerodromi (Gr. ἡμεροδρόμοι). In the ancient Greek states, couriers, so called from being able to run all day. They served, instead of a system of posts, to carry important news. They were also called Hemeroscopi (ἡμερο-

σκόποι), from being placed on some height in times of danger, to observe anything important that might happen, and give information in the proper quarter.

Hemi (Gr. ἡμι-). A prefix, denoting the half of anything.

Hemicrania (Gr. ἡμι, and κρανίον, *the head*). A pain of one side of the head: it is often intermittent. [HEADACHE.]

Hemidesmus (Gr. ἡμι, and δεσμός, *a band*). The roots of *H. indicus* are employed in India as a substitute for Sarsaparilla. The genus itself belongs to the *Asclepiadaceæ*.

Hemigamous (Gr. ἡμι, and γάμος, *marriage*). In Botany, a term employed in speaking of grasses, when of two florets in the same spikelet one is neuter and the other unisexual, whether male or female, as in *Ischæmum*.

Hemiologamous (Gr. ἡμι; ὅλος, *entire*; and γάμος). A term employed in speaking of grasses, when in the same spikelet one of two florets is neuter and the other hermaphrodite, as in several species of *Panicum*.

Hemiopia or **Hemiopsia** (Gr. ἡμι, and ὤψ, *the eye*). A disordered vision, in which objects appear divided.

Hemipinic Acid. Semi-opianic acid. An acid obtained by the oxidisement of the *opianic acid*.

Hemiplegia (Gr. ἡμιπληξία, from πλήσσω, *I strike*). Paralysis of one side of the body.

Hemiptera (Gr. ἡμι, and πτερόν, *a wing*). An order of Haustellate insects, having the wing-covers of a consistence intermediate between the elytra of beetles and the ordinary membranous wings. By Latreille the term is restricted to those insects the wing-covers of which are coriaceous at the base and membranous at the top; the term *Homoptera* being applied to those Fabrician *Hemiptera* of which the elytra are deflected and of uniform consistence throughout.

When the *Hemiptera* quit the egg they present the form of small hexapod larvæ, differing but little from the perfect insect save in the absence of wings: before these are acquired the skin is shed several times, during which the larva acquires an increase of general bulk. The pupa is active, and is distinguished by having the wings and elytra concealed in small dorsal cases: the next moulting exhibits the perfect insect with the hemelytra and wings fully developed. The bed-bug (*Cimex lectularius*) and water-boatman (*Notonecta*) are examples of the present order of insects.

Hemisphere (Gr. ἡμισφαίριον). In Geometry, the half of a sphere cut off by any plane passing through the centre. In Astronomy, it is used to designate the half of the terrestrial sphere divided by the equator. Hemisphere also denotes a map or projection of half the terrestrial or celestial sphere on a plane.

Hemispheres. In Anatomy, the two moieties of which the cerebrum is chiefly composed: in man and mammalia they approach the hemispheric form; but in most of the lower vertebrata, where the cranial cavity affords more room for the small brain, both moieties are spherical.

Hemistich (Gr. ἡμιστίχιον, from στίχος, *verse*). In Poetry, half a verse. The unfinished verses in Virgil's *Æneid*, concerning which it is not known whether they were purposely left in that state, or are owing to the incompleteness of the poem, are usually called *hemistichs*. The alexandrine, or French hemi-verse, requires a regular pause at the end of the first hemistich.

Hemitrope (Gr. ἡμι, and τρέπω, *I turn*). A term applied by some crystallographers to what are usually called *twin crystals*, from their being generally conceived to result from the cutting, as it were, a crystal in half, and then turning one of the halves half round upon the other. The plane common to the two portions of the crystal is called the *twin plane*. These crystals are often distinguished by the presence of notches or *re-entering angles*.

Hemlock. The *Conium maculatum* of botanists, a common Umbelliferous plant of a peculiar odour, and possessed of narcotic powers. For medical use the leaves should be collected just before the plant flowers; if intended for powder, they should be carefully dried at a temperature not exceeding 212°; if for extract, the juice should be squeezed out by moderate pressure, and evaporated in a water or steam bath to a proper consistency. The *extract of hemlock* is perhaps the best preparation; but as its activity is liable to vary, it should be given with caution. An average dose is five grains. An over-dose produces giddiness, wandering of the mind, dilated pupil, convulsive motions of the muscles of the face, and the other symptoms of this class of poisons. Hemlock is a powerful sedative, and often serviceable as a substitute for or an accompaniment to opium. In allaying morbid irritability of the system attended by any local or general excess of vascular action, as in certain stages of phthisis, in the coughs that are apt to hang about patients who have suffered from pulmonic inflammation, in glandular tumours and unhealthy sores, hemlock is often preferable to opium. It has also been found useful in chronic rheumatism, and occasionally in the treatment of hooping cough. A poultice composed of a mixture of finely powdered fresh hemlock with bread and water, or with extract of hemlock, is applied to allay the pain of irritable ulcers and cancerous sores; it is sometimes singularly effectual, at others it seems inert, and sometimes appears to increase irritation. The virtues of hemlock reside in a peculiar alkaloid, *Conia*, which is represented by the formula $C_{16}H_{16}N$; it is obtained in the form of a volatile oil-like body when the leaves or seeds of hemlock, previously triturated with caustic lime or potash, are carefully distilled with water. Its properties have been investigated by Geiger, and by Christison (*Edinb. Phil. Trans.* 1836). [CONINE.]

Hemp (Ger. hanf). The fibres of the bark of the *Cannabis sativa*. It is prepared for spinning in the same way as flax, and is made into strands or yarn for ropes, sailcloth, &c. This plant is supposed to be a native of India, but it has long been naturalised and extensively cultivated in Italy, and many other countries of Europe, particularly Russia and Poland, where it forms an article of primary commercial importance. It is also cultivated to a considerable extent in many parts of America. [CANNABIS.]

Henbane. The *Hyoscyamus niger*, a dingy viscid herb. The expressed juice of the leaves evaporated to the consistency of extract has long been used as a sedative or narcotic. It has a peculiar strong and disagreeable odour, and a nauseous bitterish taste. From two to five grains of the extract of henbane are often found equivalent to about one grain of *opium*, and where the latter disagrees it sometimes produces quiet. in many cases henbane and various forms of opium may be combined. Henbane is apt to produce giddiness; but it does not constipate the bowels, and has rather a diuretic tendency. [HYOSCYAMIA.]

Hendecagon (Gr. ἕνδεκα, *eleven*; γωνία, *angle*). A plane rectilineal figure of eleven sides. The area of a *regular* or equilateral and equiangular hendecagon is, approximately, equal to 9·36564 times that of the square on one of its sides.

Hendecasyllabic (Gr. ἕνδεκα, and συλλαβή, *a syllable*). A verse of eleven syllables. The Latin hendecasyllabic, of which the principal specimens left to us are from the pen of Catullus, consists of a spondee, dactyl, and three trochees—

Passer deliciæ meæ puellæ.

The Italian heroic verse, and those of England and Germany, when increased by the addition of a final short syllable, are iambic hendecasyllabics.

The license of adding an eleventh syllable (and sometimes also a twelfth) is more frequently admissible in English dramatic than epic versification.

Henna. A yellow pigment, obtained from *Lawsonia alba* or *inermis*, a plant of the order *Lythraceæ*. It is much used throughout the East, for staining the nails of the fingers, and the manes and hoofs of horses.

Henoticon (Gr.). In Ecclesiastical History. The name given to the Edict of Union, issued A.D. 482, by the emperor Zeno, with the design of ending the Monophysite controversy by avoiding all expressions offensive to either party. The success of the measure was very partial. (Milman's *History of Latin Christianity*, book iii. ch. i.)

Henricians. The followers of an Italian monk of the name of Henry, who in the twelfth century traversed the south of France from Lausanne to Toulouse, and met with great success at all the towns at which he halted. He rejected the baptism of infants, and declaimed vehemently against the vices of the clergy. At length his followers were turned against him by the eloquence of St. Bernard, and he died in prison, into which he had been thrown by Eugenius III., in the year 1148. (Milman's *Latin Christianity*, book ix. ch. viii.)

Hensloviaceæ (Henslovia, the only genus). A small natural order confined to the single genus *Henslovia*, which Lindley places near to *Hydrangeaceæ*; their chief distinction, he observes, consisting in the complete adhesion of the styles into one undivided cylinder. They are tropical plants interesting only to botanists.

Hep or **Hip.** The fruit of the Dog Rose, *Rosa canina*. [HAWTHORN.]

Hepar (Gr. ἧπαρ). This term, signifying *liver*, was applied by the old chemists to various compounds of sulphur with the metals, having a brown-red or liver colour.

Hepatalgia (Gr. ἧπαρ, and ἄλγος, *pain*). A painful affection of the liver.

Hepatic Air (Gr. ἧπαρ). Sulphuretted hydrogen, or hydrosulphuric acid, of modern chemistry.

Hepaticæ (Gr. ἧπαρ, from the form of the leaves of some of the species). A natural order or principal group of flowerless plants, growing in damp shady places in all temperate climates; in some respects allied to mosses, and in others to lichens. They are of no known importance. The *Marchantiaceæ*, *Jungermanniaceæ*, and *Ricciaceæ* belong to this group: the first known by its valvate capsules placed on the underside of a stalked target-shaped disc; the second by its solitary fruit splitting into four equal valves; and the third by its valveless capsules being sunk in the frond or seated on its surface.

Hepatite. A mineralogical name of some of the varieties of sulphate of baryta which have a liver colour.

Hepatitis. Inflammation of the liver. The acute or active form is scarcely known in England, it being a disease almost peculiar to warm climates. It is very prevalent in the East Indies. It attacks the lobules of the liver more particularly, and is characterised by violent inflammatory symptoms, and abscess of the organ is by no means an uncommon sequel of the attack. The symptoms are severe pain over the region of the liver and about the right shoulder, inability to lie on the right side, vomiting, dry cough, and hiccup. The treatment consists in purging by neutral salts, and the application of blisters and counter-irritation in other forms. Mercury is used by some in the early stage of the disease, while others of equal experience condemn the practice. Chronic hepatitis is common in this country. The form most commonly met with produces after a time a deposit in the organ, and contraction sometimes follows. It is thus that the drunkard's liver, or hobnail liver, as it is familiarly called, is produced. The treatment of this disease consists in the careful administration of alteratives, especially mild mercurials, and the daily exhibition of tonics and neutral salts. Jaundice is an occasional, but by no means a

necessary accompaniment of hepatitis, and this remark applies to both the acute and chronic forms.

Hephaestus (Gr. Ἥφαιστος). This word, signifying originally brilliance, as of flame, became in Greek mythology the name of the god of fire, who is spoken of as a son of Zeus and Hêrê, and who is the husband, in the *Iliad*, of a Charis [CHARITES], and, in the *Odyssey*, of Aphroditê. The Latins identified him with their god VULCAN [which see].

Heptagon (Gr. ἑπτάγωνος). In Geometry, a plane figure of seven sides. The area of a regular heptagon is equal to the square of one of its sides multiplied into the constant number 3·6339124.

Heptagonal Numbers. Figurate numbers of the second order and fifth class. [FIGURATE NUMBERS]; they are formed by the successive addition of the terms of the arithmetical series 1, 6, 11, 16, &c. whose common difference is 5. Thus the first four heptagonal numbers are 1, 7, 18, 34, and the n^{th} is

$$\frac{n}{2}(5n-3).$$

Heptandrous (Gr. ἑπτά, and ἀνήρ). In Botany, a flower having seven stamens.

Heptarchy (Gr. ἑπτά, and ἄρχω, *I govern*). In English History, the division of England into seven Anglo-Saxon kingdoms, which are represented in most of our histories to have existed at the same time with and independently of each other. The seven kingdoms in question, according to the common divisions, were Kent, Sussex, Wessex, Essex, East Anglia, Mercia, Northumberland. But in point of fact there was no period of history when these seven kingdoms existed together; and, in the constant fluctuations of conquest, fresh subdivisions and unions of territory were continually made by the fortune of war. The sovereign who succeeded in obtaining a temporary supremacy over his neighbour kings generally assumed the title of Bretwalda, or ruler of the Britons, of whom Ælle or Ella, king of Wessex, was the first; but it was afterwards borne by kings both of Kent, East Anglia, and Northumbria. [BRETWALDA.] In 617, Edwin, king of the latter district, appears to have acquired a temporary sovereignty over the whole of England, which was also gained by his nephew Oswald in 634; but after the brother of the latter king, Oswio, no Anglo-Saxon monarch assumed the title of Bretwalda. After the death of the latter, Mercia rose in the scale; and its king, Offa, ruled nearly the whole of the Anglo-Saxon territories in the last half of the eighth century. After his death Egbert, king of the West Saxons, raised his power on the ruins of that of Mercia; and having subdued and rendered tributary the other kingdoms then subsisting, he became, about 830, master of the whole Anglo-Saxon realm, and is reckoned as the eighth Bretwalda or ruler of Britain. With his reign the heptarchy is usually considered to have ended. (Palgrave's *History of England*; Turner's *Anglo-Saxons*.)

Heptyl. A hydrocarbon $= C_7H_{15}$, constituting the radical of *heptylic* or *œnanthylic alcohol*, a compound obtained from fusel oil. Heptyl has not been isolated.

Hera or **Hêrê** (Gr.). This word, signifying literally a mistress, reappears apparently in the German herr, *lord*. In Greek mythology, the name was confined to the daughter of Cronos and Rhea, and the wife of Zeus, whose name in the Æolic dialect, Ἔῤῥος, is only a masculine form of Hêrê. In the Homeric poems she is strictly subject to her husband: the idea of Hêrê as queen of heaven is of later date. In Latin mythology, Juno takes the place of Hêrê. [JUNO.]

Heracleonites. An early sect of heretics belonging to the Gnostics, so called from Heracleon, whose tenets they embraced.

Heracles (Gr. Ἡρακλῆς). In Mythology, the Greek Heracles is represented as the son of Zeus and Alcmene, and as belonging to the race of Perseus. By the counsels of Hera (Juno), his birth was subsequent to that of Eurystheus, whom consequently he had to serve during all his life. Hence the first idea attached to him is that of a mighty being toiling for a mean and worthless master. But the characters under which he appears, range from the heroic to the comic, and even ludicrous type. To the former belongs the beautiful fable of the Sophist Prodicus on the 'Choice of Heracles,' given in Xenophon's *Memorabilia of Socrates*. The burlesque side of his character is exhibited in the *Alcestis* of Euripides. The Latin god Hercules was at first only a god of boundaries, but was afterwards confused with the Greek Heracles. For the origin of the various myths respecting Heracles, see Max Müller, *Comparative Mythology*; Cox, *Gods and Heroes*; Bréal, *Hercule et Cacus*.

Heracleum (Gr. Ἡράκλειον). A genus of large-growing Umbellifers, of so rapid a growth as to be useful for fodder, and of so noble an aspect as to rank amongst the finest of plants for ornamenting the rougher parts of a garden shrubbery or rockery. The flower-umbels are magnificent. The species have sweet and rather aromatic properties. The most remarkable is *H. giganteum*, which grows ten or twelve feet high, and bears umbels more than a foot across.

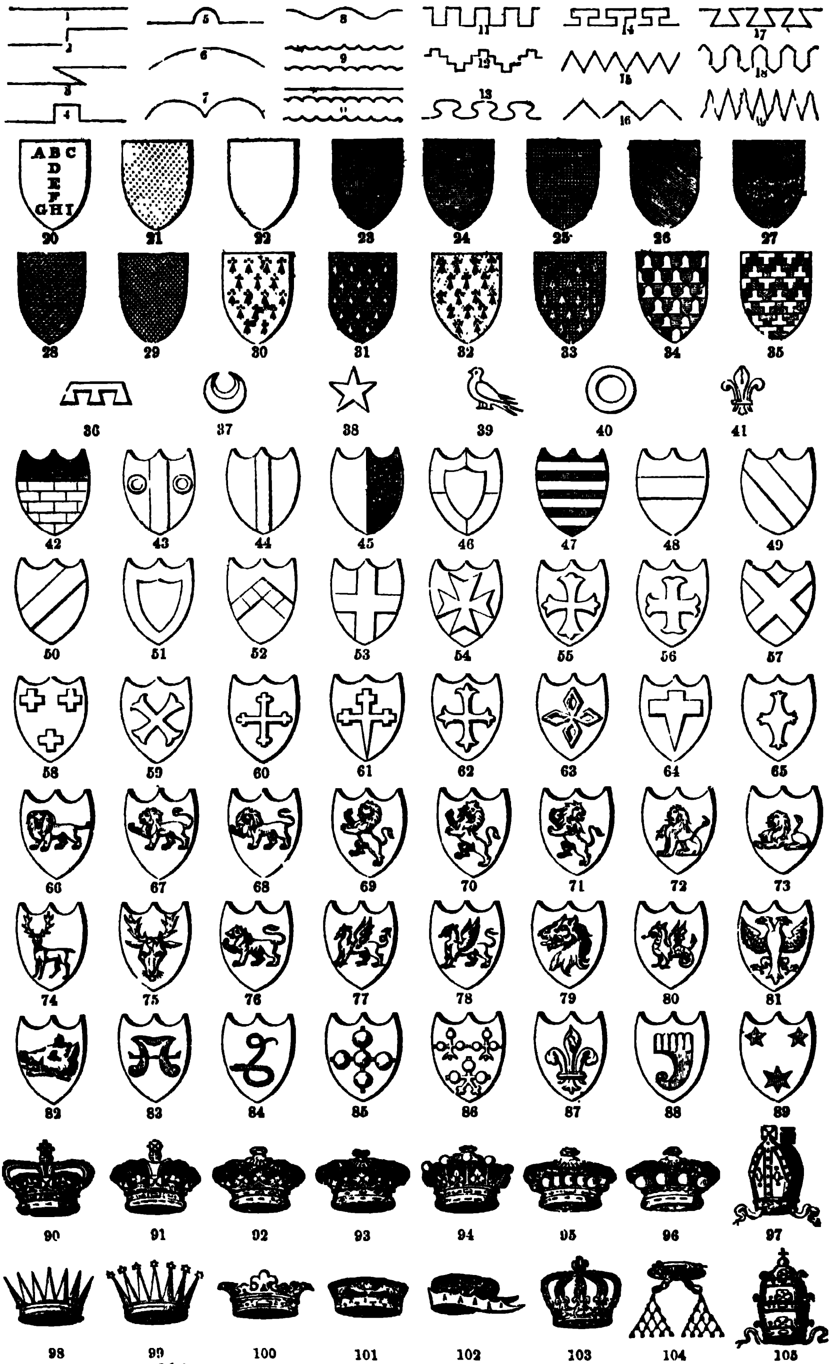
Heraclidæ. A general designation for the descendants of Hercules, who, after the death of that hero, are said to have been expelled from the Peloponnesus by Eurystheus, king of Mycenæ. The return of the Heraclidæ, which is placed about 140 years after their expulsion, has been thought to mark the transition from the heroic or fabulous ages to the period of authentic history.

Herald (Gr. κῆρυξ). An officer of arms, possessed of important functions. The ancient heralds (κήρυκες among the Greeks, feciales among the Romans) were privileged persons, sacred by superstition as well as by the law of nations. Modern heralds, besides their employment on messages between states and in

matters of public negotiation (in which capacity their services are grown into disuse, or become merely subordinate), acquired a new character from the prevalence of hereditary devices on coats-of-arms early in the middle ages. The multiplicity of these inventions rendered it necessary that there should be certain persons about a court skilled in interpreting or in *blazoning* them according to the rules of the imaginary science to which these fanciful creations were subjected. [HERALDRY.] It became also necessary that they should have a perfect knowledge of the hereditary arms, ensigns armorial, badges of honour, &c. belonging to each family, in order that they might constitute an authority to which appeal might be had in the disputes which frequently arose respecting the rights of individuals to these honourable distinctions. Hence the heralds became, in modern European countries, the depositaries of much of the genealogical science which is conversant in the pedigrees of noble or gentle families. They have also important parts to fulfil on occasions of public solemnity, pageants, installations, nuptials, funerals, &c.

Edward III. was the first English sovereign who created two heraldic kings-at-arms (Surroy and Norroy), whose office was exercised south and north of Trent respectively. Richard II. gave the earl-marshal power to preside in a court of chivalry, assisted by the heralds. But the first heraldic collegiate chapter was held at the siege of Rouen, in 1420. The kings-at-arms were fixed at three, their present number, by Henry VIII. Edward VI. fixed the establishment of heralds on the site of the building which they at present occupy in the city of London. The present Heralds' College (by which name the kings-at-arms, heralds, and pursuivants are incorporated) consists of: 1. Three kings-at-arms—Garter, Clarencieux, and Norroy; of whom the first holds the highest rank. His duties are chiefly to grant supporters to arrange funerals, and present the Order of the Garter to foreign princes. 2. The heralds are six in number; styled Windsor, Chester, Lancaster, Somerset, York, and Richmond: they, with the kings-at-arms, form the collegiate chapter. 3. The four pursuivants (Portcullis, Rouge Dragon, Blue Mantle, and Porte Croix) are junior officers, or probationers, who afterwards succeed to the higher offices. The duties of the officers of the Heralds' College are various, and their powers have been considerable, although curtailed by modern indifference to the purity of their ancient science. They keep the records of the arms, crests, and cognisances of every gentleman, i. e. person entitled to bear them; and they have considerable authority for the purpose of preventing parties from bearing arms to which they have no right. Their title to confer arms, or rather to assign coats-of-arms to persons applying for permission to bear them, is still generally recognised. Heraldic visitations of counties, with a view to collect information on the subject of genealogies and coat-armour, were held as early as the reign of Henry IV. In 1528, a regular commission was granted for the whole kingdom; and visitations were held at intervals of twenty or thirty years from that time to the beginning of the last century. (Noble's *History of the College of Arms*, 1805.)

Heraldry. The science of conventional distinctions impressed on shields, banners, and other military accoutrements. Heraldry has been divided into personal and national. The first of these treats of bearings belonging to individuals, either in their own or in hereditary right. Devices adopted by champions in the field, and borne on their shields or on their banners, are of very high antiquity. The sculptures on the shields of Achilles and Hercules, in Homer and Hesiod, are rather ornamental than heraldic. But in the drama of *The Seven Chiefs against Thebes*, by Æschylus, we find the cognisances of these renowned leaders distinctly blazoned, as worn by them on their shields, in the same fashion with those of the knights in the middle ages. The Romans do not seem to have had any customary devices for individuals resembling our armorial insignia, with the exception of their distinctive crowns for particular services. The *jus imaginum*, or right of possessing small statues of distinguished individuals of the family, seems to have been their only external hereditary distinction. Early in the middle ages, however, we find abundant notice of cognisances borne by individuals. These were more especially used in tournaments, where the knights, being clad in complete armour, were unknown to the spectators, except by their banner or shield [BLAZONRY]; and probably it was in the lists of the tournament that the fanciful science of heraldry first found its subject-matter. This science appears to be a compound of inventions collected from very different quarters. The East, the land of allegory and symbol, seems to have contributed many of its most singular devices. Its ordinaries, colours, metals, and gems, are said to be derived from Germany; and German heraldry appears to be a national science, from the circumstance that its terms of art are nearly all of native origin. But the Normans and French undoubtedly cultivated it with the greatest success, and reduced it to its present systematic form. Our English terms of heraldry are, as is well known, derived entirely from the French language, although not wholly from France; as some additions were made to the science by the Norman-English. Hereditary coat-armour, it is said, cannot be traced with certainty to an earlier period than the thirteenth century; but it seems that, in the reign of Henry III., the vocabulary of heraldry was nearly as full and definite as at the present day. National heraldry, or the adoption of distinctive emblems by civil communities, is far more ancient than personal. Badges, we know, were borne on the standards of ancient nations: an eagle was the device of Persia and of Rome, an owl of Athens, &c.; and Turkey and Persia, where personal heraldry is unknown,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possess at this day national ensigns of correct heraldic character.

Arms are said, in the heraldic science, to be of dominion or pretension (national); arms of community, belonging to episcopal sees, cities, corporations; arms of patronage, to governors of provinces, &c.; arms of concession, or augmentations of honour, granted by sovereigns to individuals, which in the next generation become hereditary; arms of family, or hereditary arms; arms of alliance, showing the union of families and relations of individuals (marked by various devices termed *differences*, &c.) [DIFFERENCE]; arms of succession, which accompany the possession of certain estates or lordships; and, finally, arms of assumption, taken up by individuals from caprice or vanity, which, although common enough in the present day, are borne in violation of all heraldic laws; or, arms taken up with the permission of the sovereign, through his principal herald (in England, king-at-arms). Armorial bearings were chiefly displayed, in the times of chivalry, on the shield or escutcheon. They were also borne on the pennon, or banner; on sword-hilts, as early as A.D. 1250; on the mantle or surcoat (hence the phrase coat-of-arms); and, in modern times, on carriages or articles of furniture. The science of heraldry, united as it is with that of family genealogy, was for centuries one of the most favourite literary pursuits (if it can be termed such) among the higher ranks of the community. It has been enriched with much legendary knowledge, and diversified with many fanciful antiquarian theories. It is entitled to respect, not merely on account of its intimate connection with historical knowledge, but also on account of the refinement and curious variety of the learning itself; which, grounded on merely imaginary principles, has been wrought into a system of the minutest accuracy. The best known English work on heraldry is that of Gwillim. The *Encyclopædia Heraldica* of Berry contains many modern additions. See also Edmonson's *Complete Body of Heraldry*, 1780; Dallaway's *Inquiries*, 1783; and the article 'Heraldry' in the *Encyclopædia Metropolitana*, with the various authorities, English and foreign, there referred to.

EXPLANATION OF THE PLATE.

I. *Lines.*

1. Horizontal or straight. 2. Angled. 3 Bevilled. 4. Escartelé. 5. Nowy or Franché. 6. Arched or enarched. 7. Double arched. 8. Wavy or undée. 9. Invected. 10. Engrailed. 11. Battled-embattled or crenellée. 12. Battled-embattled. 13. Nebuly. 14. Potent. 15. Indented. 16. Dancettée. 17. Dove-tailed. 18. Urdée. 19. Rayonnée or radiant.

II. *Points of the Escutcheon, Colours, and Furs.*

20. Escutcheon, points of. 21. Or. 22. Argent. 23. Gules. 24. Azure. 25. Sable. 26. Vert. 27. Purpure. 28. Tenne. 29. Sanguine. 30. Ermine. 31. Ermines. 32. Erminois. 33. Pean. 34. Vair. 35. Varry cuppy.

III. *Differences or Filiations.*

36. (First son) Label of three points. 37. (Second) Crescent. 38. (Third) Mullet. 39. (Fourth) Martlet. 40. (Fifth) Annulet. 41. (Sixth) Fleur-de-lys.

IV. *Ordinaries, &c.*

42. Chief. 43. Pale (between two annulets). 44. Pallet. 45. Party per pale. 46. Border. 47. Bars. 48. Fess. 49. Bend. 50. Bend sinister. 51. Border. 52. Chevron. 53. Cross. 54. Cross of St. John of Jerusalem or Malta. 55. Cross patonce. 56. Cross moline. 57. Cross of St. Andrew. 58. Crosses humettée. 59. Cross moline in saltier. 60. Cross bottonée or trefoil. 61. Cross crosslet, fitchée. 62. Cross flory. 63. Cross mascle. 64. Cross fitchée. 65. Lozenge, fleury.

V. *Miscellaneous Bearings.*

66. Lion, statant guardant. 67. Passant. 68. Passant guardant. 69. Rampant. 70. Rampant guardant. 71. Rampant reguardant. 72. Sejant. 73. Couchant. 74. Stag at gaze. 75. Stag's head caboshed. 76. Tiger, heraldic. 77. Dragon. 78. Griffin. 79. Dragon's head erased. 80. Wivern. 81. Eagle displayed, with two heads. 82. Boar's head erased. 83. Water-bougets. 84. Snake, bowed-de-bruised. 85. Quatrefoil. 86. Trefoils. 87. Fleur-de-lys. 88. Clarion or rest. 89. Mullets.

VI. *Crowns, Coronets, &c.*

90. Crown of England. 91. Coronet of the Prince of Wales. 92. Coronet of a duke. 93. Marquis. 94. Earl. 95. Viscount. 96. Baron. 97. Mitre of a bishop. 98. Eastern or antique coronet. 99. Celestial crown. 100. Crown of Edward I. 101. Mortier, or cap of state. 102. Chapeau, or cap of maintenance. 103. Crown of France. 104. Cardinal's hat. 105. Crown triple, or tiara of the pope.

The principal of these heraldic terms will be found explained under their several articles in the Dictionary.

Herbaceous (Lat. herba). A term used in Botany, in describing the texture of bodies, denoting their being green and cellular, as the tissue of membranous leaves. It is also applied to such perennial plants as lose their stems annually, while their roots remain permanent in the ground.

Herbaria. Collections of dried plants, such as the old botanists called *Horti Sicci* or dry gardens. If well prepared, they are nearly as useful to the botanist as fresh plants; but it is necessary to have some practical skill to be able to employ them advantageously. The largest public herbaria are those of the Museum at Paris, the Imperial collection of Vienna, the Royal collection of Berlin, that of the Royal Gardens, Kew, and that of the late Sir Joseph Banks, now in the British Museum. The herbarium, though an unattractive part of public museums, is very important for many purposes of science.

Hercules (Lat.). In Astronomy, one of the old constellations in the northern hemisphere.

HERCULES. In Mythology. [HERACLES.]

Herderite (so called from Herder, who discovered it). A mineral found in crystals embedded in Fluor at Ehrenfriedensdorf, in Saxony.

Hereditaments (Lat. hæres, *an heir*). In Law, all things which pass to the heir, being either corporeal (land, with those adjuncts which legally are comprised within that designation), or incorporeal, which are things collateral to land, or issuing out of it, and are enumerated in Blackstone's *Commentaries*, under the heads 'Advowsons, Tithes, Commons, Ways, Offices, Dignities, Franchises, Corodies or Pensions, Annuities, and Rents.'

Heresy (from the Greek αἵρεσις, *choice*, which classical writers apply to the sects of philosophers). This word is now confined to a theological sense, and is defined by Roman Catholic authorities to be the *voluntary* assumption and

obstinate maintaining of error in matters of faith. They hold all error to be voluntary where the party knowingly deviates from the judgment of the church. The Protestants do not for the most part profess to have any certain standard by which men may judge whether their fellow men be heretical. The statute 1 Eliz., directing the mode of procedure against heretics, declares that no matter or cause shall be adjudged heresy 'but only such as heretofore has been adjudged to be heresy by the authority of the canonical Scriptures, or by some of the first four general councils, or by any other general council wherein the same was declared heresy by the express and plain words of the same canonical Scriptures, or such as hereafter shall be judged or determined to be heresy by the High Court of Parliament, with the assent of the clergy in their convocation.'

For the connection of theories of heresy with the practice of persecution, see Lecky, *History of the Rise and Influence of Rationalism in Europe*.

Heretoch (Ger. herzog). The Anglo-Saxon name for the persons who were elected by the folkmote or full assembly of the people to lead the armies of the kingdom.

Heriot. In Law, originally a tribute given to the lord of the manor on occasion of his engaging in a war (here or heer geld). In English law a heriot is a customary service, due for the most part on copyhold tenures, and termed *heriot custom*, being usually the best beast, whether horse, ox, or cow, that the tenant dies possessed of; this is due and payable to the lord of the manor. Some heriots, however, are due on reservation in a grant or lease of land; such are termed *heriot service*. In heriot custom the lord may seize the specific article which he seeks to recover; for heriot service he may either seize or distrain generally on the goods of the tenant on the land.

Herisson (Fr.). In Fortification, a beam armed with iron spikes, and used as a barrier to block up a passage.

Heritable Rights. In Scottish Law, comprehend in general rights to land and things connected with land which pass to the heir; the distinction being in most practical respects identical with that of English law between realty and personalty. Heritable jurisdictions were grants of criminal jurisdiction bestowed on great families by the crown. They were abolished after the rebellion of 1745 by the Act 20 Geo. II. c. 43.

Hermae (Gr. Ἑρμαῖ). In Grecian Antiquities, small figures or busts of Hermes fixed on quadrangular pedestals on the side and at the crossing of roads. The mutilation of the Hermæ at Athens just before the departure of the Sicilian expedition led to the desertion of the Athenians by Alcibiades. (Thucydides vi. 28, 61 &c.)

Hermaphrodite (Gr. Ἑρμαφρόδιτος, the mythical son of Hermes and Aphroditê). An organised body, in which there is either a real or apparent combination of the characteristics of the two sexes. The first is the *true*, the second the *spurious* hermaphrodite. Hermaphrodites are also *natural* or *preternatural*.

The animals in which the organs of the two sexes are naturally combined in the same individual are confined to the invertebrate division, and are most common in the Molluscous and Radiate classes. If the term *hermaphrodite* may be applied to those species which propagate without the concourse of the sexes, but in which no male organ can be detected, as well as to those in which both male and female organs are present in the same body, then there may be distinguished three kinds of hermaphroditism.

First, The *Cryptandrous*, in which the female or productive organs are alone developed.—Ex.: The cystic Entozoa, the hydrostatic Acalephes, some Polypes, and Sponges.

Second, The *Heautandrous*, in which the male organs are developed, but so disposed as to fecundate the ova of the same individual.—Ex.: The Cirripeds, the Rotifers, the trematode and cestoid Entozoa, and some Acephala, as the *Cyclas*.

Third, The *Allotriandrous*, in which the male organs are so disposed as not to fecundate the ova of the same body, but where the concourse of two individuals is required, notwithstanding the coexistence in each of the organs of the two sexes.—Ex.: The gastropodous Molluscs, with the exception of the Pectinibranchiate order, and class *Annelida*.

All the other invertebrates, as the Cephalopods and pectinibranchiate Gastropods, most of the acephalous Molluscs, the insects, Arachnidans and Crustaceans, the Epizoa and the nematoid Entozoa, the Echinoderms and Medusæ, are, like the vertebrate classes, diœcious, or composed of male and female individuals.

The unnatural hermaphrodites may be divided into those in which the parts peculiar to the two sexes are blended together in different proportions, and the whole body participates of a neutral character, tending towards the male and female as the respective organs predominate; and into those in which the male and female organs occupy respectively separate halves of the body, and impress on each lateral moiety the characteristics of the sex.

This latter and very singular kind of hermaphroditism has hitherto been found only in insects and Crustaceans. In the extracts from the Minute Book of the Linnæan Society, printed in the fourteenth volume of their *Transactions*, it is stated that Alexander Macleay, Esq., Sec. L.S., exhibited a curious specimen, showing that two Papiliones referred to distinct families by Fabricius are in reality the male and female of the same species. This specimen presented the forms and colours of both sexes, divided by a longitudinal line on the body; the right wings and side of the body being as in the male (*Papilio Polycaon*,

Fabr.), and the left as in the female (*Papilio Laodocus*, Fabr.).

In Loudon's *Magazine of Natural History* (vol. iv. p. 434), an experienced entomologist, Mr. J. O. Westwood, has given descriptions and figures, not only of dimidiate hermaphrodites (the example is the *Bombyx penii*), but also of quartered hermaphrodites. The latter singular condition is exemplified in a specimen of the *Bombyx castrensis*, in which the right wing, left antenna, and left side of the abdomen are male; the left wing, right antenna, and right side of the abdomen are female: and again in a specimen of stag-beetle (*Lucanus cervus*), in which the left jaw and right elytrum are masculine, and the right jaw and left elytrum feminine.

In most dimidiate hermaphrodites the left side is masculine; but an example of the contrary has been observed in *Sphinx populi*. It is to be regretted that the condition of the internal organs of generation cannot be ascertained in the above singular examples; but this deficiency is in some degree supplied by the results of Dr. Nicholl's dissection of an hermaphrodite lobster (*Phil. Trans.* xxxvi. p. 290), in which a testis was found on that side of the body which exhibited externally the male characteristics, and an ovarium on the opposite side.

HERMAPHRODITE. In Botany, when a flower contains both stamens and pistils. Hermaphroditism is the rule, and a separation of sexes the exception, in the structure of flowers.

s (Gr.). In Greek Mythology, the messenger of the gods. In the Homeric hymn, which gives the myth of Hermes in its most beautiful form, he is the son of Zeus and Maia, who before he is a day old forms a lyre out of a tortoise-shell, and steals the cattle of Phœbus. The enmity caused by this theft between the two gods is appeased by the intervention of Zeus; and Hermes, who gives to Phœbus the power of drawing sweet music from his harp, receives in return the gift of wisdom, and the office of guiding the souls of the dead to their shadowy kingdom. In the mind of the Homeric hymnographer, Hermes appears manifestly as the embodiment of air in motion; as he rises from his cradle, his breath is soft as a summer breeze; but when he exerts his strength, the branches of the forest, rubbed against each other, burst into flame; and hence he is known, like Prometheus, as the giver of fire. In the Vedas, the name occurs in the form Saramâ, which is one of the epithets of the Dawn as it comes forth with the fresh morning breeze. The Greek mind fastened apparently on the idea of the breeze, and dwelt on it almost to the exclusion of the idea of morning. The name Saramâ is identified with that of Helen; between whom and Hermes a mythical connection is thus established. For an examination of the myths of Hermes, see Max Müller, *Lectures on Language*, second series, p. 462 &c.; Cox, *Tales of Thebes and Argos*, Introduction, p. 45 &c. [MERCURY.]

Hermetic Art. The imaginary art or science of alchemy; so termed from Hermes Trismegistus, a personage of questionable reality, looked up to by the alchemists as the founder of their art. Some spurious works bearing his name are still extant. [ALCHEMY.]

Hermetic Seal. When a vessel or tube is perfectly closed by fusing its mouth or extremity, it is said to be *hermetically sealed*.

Hermits or **Eremites** (Gr. ἐρημίτης). Persons who, in the early ages of Christianity, secluded themselves from the world for devotional purposes, in solitary and desert places (ἐρημός), whence their name. [MONACHISM.]

Hermodactyls (perhaps named from Hermus, a river in Asia Minor, and dactylus, *a date*: or from Ἑρμῆς, and δάκτυλος, *finger*; i.e. *the fingers of Hermes*). This term has long been applied to a species of colchicum tuber, probably that of the *Colchicum illyricum*: it is irregularly heart-shaped, and has a furrow upon one side, not unlike the tuber of the *Colchicum autumnale*, now much used in the cure of gout: it is imported from Turkey, and was formerly esteemed as a cathartic. Some of the old writers who are fond of the doctrine of signatures, compare the shape of the hermodactyl to that of a gouty finger, and have recommended its efficacy in that disease.

Hernandiaceæ (Hernandia, one of the genera). A small natural group of arborescent Exogens of the Daphnal alliance, inhabiting the Indian Archipelago and Guinea. They are very near *Thymelaceæ*, with which Lindley associates them, differing only in their fibrous drupaceous fruit, lobed cotyledons, and involucre. The leaves, stem, &c. are slightly purgative. The roots of *Hernandia sonora* are antidotes to the Macassar poison, and its juice is a depilatory, while the wood of *H. guianensis* makes a good sort of tinder.

Hernia (Lat.). A rupture. The term is generally applied to a tumour arising from a protrusion of part of the intestines or omentum into a sac composed of peritoneum: the groin, or upper and fore part of the thigh, below Poupart's ligament, are common situations. Other viscera may also occasionally form hernial tumours. When the condition of the accident is such that the parts cannot be reduced or returned into the abdominal cavity, the hernia is said to be *incarcerated* or *strangulated*. In the latter case the passage through the intestines is interrupted; there is sickness and constipation; and inflammation, and even mortification of the part ensue, unless by an operation the cause of the stricture is removed and the gut returned. What is termed *congenital hernia* is the protrusion of a portion of intestine along with the testicle in its descent through the abdominal ring into the scrotum. Where a rupture exists in early infancy, it is commonly referable to this cause. The surgical history of ruptures is a very complicated and extensive, but highly important subject: it has been ably illustrated by several eminent practitioners.

Hero (Gr. ἥρως). This word probably belongs to the same root with the Latin herus, the German herr, and may be compared with the Greek HERA. In the Homeric poems, it occurs as a title of honour, not only for those who were employed as leaders or fighting men in war (the Danaans and Achæans being collectively called *heroes*), but even for heralds and minstrels, and for the unwarlike Phæacians. (*Od.* vii. 44.) In the Hesiodic *Theogony*, the heroes are represented as a race of men interposed between the brazen and the iron age [AGE], who fought at the sieges of Troy and Thebes. The exaltation of this race, which even in the *Iliad* (xii. 23) is styled a race of demigods, was completed before the time of Pindar, who makes them a race between gods and men. As so used, the term denoted especially those who were sprung from the union of a divine with a mortal being; as Perseus from that of Zeus with Danaê, and Achilles from that of Thetis with Peleus. But in the later historical writers, the heroes are commonly inferior local deities, as for instance the eponymous heroes of the Attic tribes. Their chapels, termed Ἡρῷα, although supported by the state, were always distinct from the temples of the national gods.

Hero's Fountain. [FOUNTAIN OF HERO.]

Herodians. A sect existing among the Jews at the period of our Saviour's preaching. (Matthew xvi.; Mark viii. 15.) Much doubt exists as to their history and tenets; some commentators, both ancient and modern, imagine that they were fanatics, who regarded Herod the Great as the Messiah; others, that they were a mere political party, attached to the family of Herod; while a third opinion (Bergier, *Dictionnaire de Théologie*) is, that they supported some innovations attempted by Herod in the religious observances of the country by the partial introduction of Pagan usages. (Milman's *History of Christianity*, i. 311.)

Heroic Verse. The verse appropriated to epic or heroic poetry: in Greek and Latin, the hexameter. In English, Italian, and German, the iambic of ten syllables, either with or without the additional short syllable. In French, the iambic of twelve syllables. [EPIC; HEXAMETER.]

Herpes (Gr.). A disease of the skin consisting in the eruption of small aggregated vesicles. Several varieties of herpes are mentioned by systematic writers on skin diseases. A common form is familiarly known as *shingles*. In this, which though not a dangerous is a very troublesome disease, patches of herpetic vesicles extend either quite around or half around the body near the waist. The treatment of herpes in its several forms consists merely in correcting the state of the secretions by alteratives and aperients.

Herpestes (Gr. ἑρπηστής, *a creeper*). A genus of Viverrine *Carnivora*, comprising the various species of *Ichneumon*. These animals are celebrated for the instinct which Kæmpfer attributes to them of destroying serpents, and curing themselves from their venomous bites by rubbing themselves on the plant named *Ophiorhiza Mungos*. The legends recorded by Herodotus of the connection between the ichneumon and the crocodile are well known. The genus is confined to the Old World.

Herpetology (Gr. ἑρπετόν, *a reptile*, and λόγος). The branch of zoological science which specially treats of the class *Reptilia*. This class of animals is characterised by having a heart so constructed as to transmit to the lungs a part only of the circulating mass of blood which it receives from the systenni veins, the remainder being sent again to the body without having been purified in the lungs. There thus results a less amount of reaction of oxygen upon the blood than takes place in Mammalia, and consequently a lower grade of animal heat, and an inferior activity of muscular contraction; but, as the proportion of venous blood transmitted by the heart to the general system varies in different reptiles with the various modifications of the heart, there is a corresponding difference in the manifestation of their vital phenomena.

As reptiles are thus exempt from the office of preserving the temperature of a circulating fluid many degrees warmer than that of the external atmosphere, they have no need of teguments adapted to retain heat; and are accordingly naked, or covered with scales or hard bony plates. Their brain is very small, and without the great commissures. The lungs serve more or less as reservoirs as well as decomposers of the atmospheric air; and thus with a certain degree of independence of the general circulation, the reptiles are enabled to remain much longer under water than either birds or mammalia. Some species indeed have, in addition to their lungs, gills for breathing water, either during their immature state, or throughout life, and thus are truly amphibious. With a cold blood, low respiration, low sensation, and sluggish habits, is associated an extraordinary power of endurance under abstinence or against bodily injury.

Reptiles are either oviparous, or ovoviviparous: they do not incubate. They present a great variety of forms, and constitute altogether a much less natural group than either birds or mammals. The character which Cuvier has assigned to the *Reptilia* would not seem to distinguish them from certain fishes with highly developed air-bladders, without the additional statement that the organ of smell in the class *Reptilia* is situated in a canal communicating both with the cavity of the mouth and the external surface.

Cuvier, after Brongniart, divides the reptiles into four orders, viz.:—

The *Chelonia* (tortoises and turtles); of which the heart has two auricles, and the body is supported on four legs, and enclosed between two plates or shields formed by the ribs and sternum.

The *Sauria* (lizards and crocodiles); of which the heart has two auricles, and the body, supported on four legs, is covered with scales.

The *Ophidia* (slow-worms and serpents); of which the heart has two auricles, and the body is without legs.

The *Batrachia* (frogs, toads, newts, &c.); of which the heart has but one auricle, and the body is naked, and supported on four, or in a few cases two, legs. Most of these pass, as they advance to maturity, from the condition of a fish breathing by gills to that of a quadruped breathing by lungs. Some, however, never lose their gills.

Such are the characters assigned by Cuvier (in 1829) to his primary divisions of the class *Reptilia*, but they are not a true expression of the organisation of the groups so distinguished. The *Batrachia*, for example, have since been proved to have two auricles, although not so distinct externally as the other reptiles. Some of Cuvier's *Sauria*, again, have two distinct ventricles; whilst the rest have but one, like the *Chelonia* and *Ophidia*. The crocodiles, alligators, and gharrials are the higher organised *Sauria* here referred to; and since they differ also from the *Lacertine Sauria* in having a simple undivided tongue and intromittent organ, and a well-marked modification of the tegumentary system, they deserve to rank as a distinct order, at the head of the class *Reptilia*. This order has been termed by Merrem *Loricata*; for the skin, in fact, instead of being covered by imbricated scales, is strengthened and protected by several rows of flattened and generally elliptical bones, developed between the cuticle and true skin, and often supporting a longitudinal crest; these bones or scutæ are situated chiefly along the back part of the neck, body, and tail.

Another order of *Reptilia* is clearly indicated by the remains of several large or even gigantic species now extinct, in which the extremities were modified to serve as fins on the plan of the paddles of the *Cetaceæ*. These reptiles are chiefly referable to the genera *Ichthyosaurus* and *Plesiosaurus*; they were marine, and of predaceous habits, and constitute the orders *Ichthyopterygia* and *Sauropterygia*.

The *Chelonia* form a third and very natural order.

Those *Saurians* of Cuvier which have a heart composed of a single ventricle and two auricles, a bifid tongue and double intromittent organ, as well as a scaly and generally imbricated covering, form a fourth order of reptiles, to which the term *Squamata* has been given.

The *Ophidia* of Cuvier constitute the fifth order of reptiles. Some naturalists have proposed to unite the serpents with the lizards in the same order, on account of the gradual transition traceable in different genera from one to the other group; but the class of reptiles, by parity of reasoning, ought to be merged in that of fishes; and the naturalists who favour the blending of the tetrapodal with the apodal reptiles seem to forget that an order is a conventional division, a group of convenience, and not an entity circumscribed by nature. To separate the *Batrachia* as a distinct class from the *Reptilia*, seems to be an error in the opposite extreme. The viviparous four-footed salamander, breathing air by membranous lungs, and circulating blood by a biauricular heart, is thus placed in a distinct class from the four-footed lizard, without any essential difference in the pulmonary or sanguiferous systems to warrant the separation; the only differences that can be urged for such a step are a modification of the tegumentary covering, and a greater developement and later continuance of the temporary branchial apparatus, of which traces are met with in the embryos of all the air-breathing Vertebrata; and a modification of the reproductive system. The naked integument; the presence of external gills in the young state; the almost simultaneous fecundation, sometimes without intromission, of numerous ova—may be grounds for regarding the *Batrachia* and *Amphibia* as a subclass, or a group somewhat higher than an order; but seem not to warrant their separation from the scaled reptiles as a distinct class, as a group equivalent among Vertebrata to that of birds or mammals. For the subdivisions of the above orders, see LORICATA; ENALIOSAURIA; CHELONIA; SQUAMATA; OPHIDIA; BATRACHIA; and also AMPHIBIA.

The orders of reptiles *Ganocephala*, *Anomodontia*, *Pterosauria*, *Thecodontia*, *Dinosauria*, and *Labyrinthodontia* are only found in a fossil state.

Herpeton (Gr. *a reptile*). A genus of serpents, allied to *Eryx*; and characterised by two soft prominences covered with scales which are appended to the muzzle. Botanists have a *herpeton* which is a section of *Viola*.

Herpolhode (a word coined from the Gr. ἕρπω, *I wind along*; πόλος, *an axis*; and ὁδός, *a road*). A plane transcendental curve, employed first by Poinsot in his graphic representation of the motion of a body around a fixed point. [ROTATION.] It is the locus of the point of contact with a fixed plane of an ellipsoid movable around its *fixed* centre. The ellipsoidal locus of the points of contact is called the POLHODE [see the term], a curve which has obviously two maxima and two minima radii vectores proceeding from the fixed centre O. Let us call them O A, O A′ and O B, O B′ respectively, and let O P be the perpendicular on the fixed plane of the curve. If we remember that the polhode must be symmetrical with respect to the two rectangular planes A O A′ and B O B′, and consequently that its arcs AB, BA′, A′B′, B′A are equal and similar, it will be evident that the herpolhode must undulate symmetrically between two concentric circles described around P as centre, with the radii $\sqrt{OA^2-OP^2}$ and $\sqrt{OB^2-OP^2}$ respectively, which circles it will touch alternately at equidistant points a, b, a', b', &c. The herpolhode is, in general, an unclosed curve; should the angle aPb, however, be commensurable with a right angle, it will be closed. When the distance O P from the

fixed point to the fixed plane becomes equal to the mean semi-axis of the ellipsoid, the polhode becomes an ellipse having the mean axis for minor axis, so that $OP = OB = b$. The circle b, b', b'', &c., now degenerates to a point, which the herpolhode, now a spiral, approaches symmetrically, its polar equation being

$$r\,(e^{n\phi} + e^{-n\phi}) = 2nb,$$

where b is the mean axis of the ellipsoid, and $nb = \sqrt{\overline{OA}^2 - b^2}$. When the ellipsoid is one of revolution, the herpolhode, like the polhode, becomes a circle. The herpolhode is fully investigated in Poinsot's classic *Théorie Nouvelle de la Rotation des Corps*, Paris 1852.

Herring (Ger. heer, *an army*, in reference to the great numbers in which the fishes so called appear, at stated seasons, along our coasts). This name is commonly applied to two distinct but closely allied species of the genus *Clupea*, Linnæus: to the one Mr. Yarrell restricts the name *Clupea Harengus*; the other is denominated *Clupea Leachii*, in commemoration of the excellent naturalist who first appears to have been aware that our coast produced a second species of herring.

The genus *Clupea* is so nearly allied to the genus *Salmo* that they are both included in the same natural family, under the name of *Halecoids*, by M. Agassiz; the principal external difference consists in the absence of the small adipose dorsal fin in the *Clupea*. But in the clupeoids, as in the salmon tribe, the upper maxillary as well as the intermaxillary bones enter into the formation of the mouth, and are both armed with teeth; the body is always covered with numerous scales; and, in the greater number of the herring tribe, there is an air-bladder, and the duodenum is complicated with many *cæca*, or pyloric appendages.

The annual migration of the herring is not, as has been described, from one latitude to another, but simply from a deeper to a shallower part of the ocean. The common species, impelled by the stimulus of the increasing burden of milt or roe, quits the deeper recesses of the ocean, where it has passed the winter and spring months, and approaches the shallower water near the coasts, where the ova may be deposited, and impregnated with the requisite amount of heat, light, and oxygen for their developement.

The common herring visits different parts of our coast in autumn, generally earlier on the southern than on the northern localities, and deposits its ova and spawn towards the end of October. In this state the fish are termed *shotten herring*, and they retire from the shore into deep water.

Leach's herring has a different season of sexual migration. 'It is found,' says Mr. Yarrell, 'heavy with roe at the end of January, which it does not deposit till the middle of February. Its length is not more than seven inches and a half, and its depth near two inches.'

During the long period in which the herring stays in deep water, the shoals occasionally travel so far as to appear at the next season of oviposition at a different part of the coast from that where they were previously abundant. Hence the herring has been described as a most capricious fish; and it is truly said, 'that there is scarcely a fishing station round the British Islands that has not experienced in the visits of this fish the greatest variations, both as to time and quantity, without any accountable reason.'

Herrings are taken in drift nets, and during the night. The stretching of the nets in the daytime is forbidden, as it is supposed that the practice would alarm and drive away the shoal. The darkest nights, and a breeze that ruffles the surface of the water, are the circumstances which most favour the capture of the herring.

Herringbone. The name given to strutting placed between thin joists, consisting of pieces of small scantling that go from the top of one to the bottom of another joist, and respectively otherwise; it is introduced for the purpose of increasing the lateral stiffness of the joists. The same term is also applied to paving, or bricks, laid contrariwise from the same meeting line, either horizontal or vertical.

Herrnhut (Ger. *the Lord's guard*). An establishment in Upper Lusatia, comprising, it is said, at present 120 houses, with 1,500 inhabitants, and founded by a few Moravians about the year 1722, under the patronage of Count Zinzendorf. The principles of the society thus formed are seclusion from the world, the enjoyment of a contemplative life, and the possession of all goods in common. Its members are bound together, under the title of Moravian Brethren, by strict laws and observances. Accusations have been thrown out against them of indulging, in their retirement, in many licentious practices; but it is certain that their industry supplies many of the markets of Germany with various useful and ornamental articles of handiwork; that their zeal has prompted them to establish affiliated societies in many parts of Europe and America; and that in religious matters they are neither extravagant themselves, nor intolerant of others.

Herschel. [URANUS.]

Herschellite. A hydrous silicate of alumina, soda and potash, found in colourless hexagonal crystals, at Pelagonia and Aci Reale in Sicily. Named in honour of Sir J. F. Herschel.

Herse, Hersillon (Fr.). In Fortification, a lattice or portcullis armed with spikes, used to close a gateway.

Hertha (sometimes written Aertha, Aortha, and Eorthe). In Mythology, the name of a chief divinity of the ancient German and Scandinavian nations. She was worshipped under a variety of names, of which the chief were analogous to those of Terra, Rhea, Cybele, and Ops, among the Greeks and Romans. Long before the Christian era the knowledge of Hertha appears to have been extended over a great portion of Northern Europe; for Tacitus

(*Germ.* xl.) speaks of the wonderful unanimity which tribes that had no other feature in common displayed in worshipping this goddess, whom he designates Herthus, or *Mother Earth.* Her chief sanctuary was situated, according to the same writer, in a sacred grove in an island of the ocean, which, by some writers, has been supposed to be Riga, and by others Zetland or Heligoland; but no modern researches have been able accurately to fix its locality. Much curious information upon this subject is to be found in Grimm's *Deutsche Mythologie*, chap. x.

Hesperia. A genus of butterflies, now the type of a family, including several subgenera, to some of which belong the British species, eight or ten in number.

Hesperides (Gr. from ἕσπερος, *the evening*). In Greek Mythology, the guardians of the golden apples given to Hera (Juno) on the day of her marriage. The legends about them vary indefinitely in detail, some making them four, others seven in number, some speaking of them as children of Night or Erebus, some of Atlas, some of Hesperus, some of Zeus, &c. Their abode was held to be a garden in the western part of Africa, where the dragon Ladon helped them to watch the sacred fruit.

Hesperidine. An insipid white crystalline substance obtained from the soft spongy part of orange and lemon rind. It has also been called Aurantine.

Hesperidium. In Botany, a many-celled, few-seeded, superior, indehiscent fruit, covered by a spongy separable rind; the cells easily separable from each other, and containing a mass of pulp, in which the seeds are embedded—example, the orange.

Hessian. The Hessian of a quantic is best defined as the Jacobian of the system of first derived functions of that quantic. [Jacobian.] The name Hessian was proposed by Sylvester (*Phil. Trans.* 1853) in honour of Hesse, the discoverer of the function. The Hessian of the ternary quantic u is

$$H = \begin{vmatrix} \dfrac{d^2u}{dx^2}, & \dfrac{d^2u}{dx\,dy}, & \dfrac{d^2u}{dx\,dz} \\ \dfrac{d^2u}{dy\,dx}, & \dfrac{d^2u}{dy^2}, & \dfrac{d^2u}{dy\,dz} \\ \dfrac{d^2u}{dz\,dx}, & \dfrac{d^2u}{dz\,dy}, & \dfrac{d^2u}{dz^2} \end{vmatrix}$$

In general we may say that the Hessian of an m-ary n-ic is a symmetrical functional determinant of the m^{th} order whose constituents are the several second derived functions of the given quantic. It is always a covariant of the quantic of the m^{th} order in the coefficients, and of the $m\,(n-2)^{\text{th}}$ in the variables; it is, in fact, the discriminant of the second emanant

$$\left(x'\frac{d}{dx}+y'\frac{d}{dy}+z'\frac{d}{dz}+\ \&c.\ \ldots\ldots\right)^2 u$$

of the quantic, this emanant being regarded as a quadric in which the original facients $x, y, z \ldots$ are regarded as constants. [Discriminant and Emanant.]

In geometry, the Hessian of a ternary quantic when equated to zero, represents the important curve, known also as the Hessian of that which is represented by equating to zero the quantic itself. The Hessian of any curve of the n^{th} order is a curve of the $3(n-2)^{\text{th}}$ order, which not only passes through all the double points of the original, but has itself double points which coincide with the latter.

Now the second emanant represents the polar quadric of any point with respect to the given curve, so that from what precedes the Hessian may be regarded as the locus of all points whose polar quadrics break up into pairs of right lines, whence it follows that the Hessian also passes through the points of inflexion of the original curve. (Salmon's *Higher Plane Curves.*)

It is scarcely necessary to observe that the Hessian of a ternary quadric no longer represents a curve; it is simply the discriminant of the quadric, and, equated to zero, expresses the condition under which the quadric in question will break up into a pair of right lines.

The Hessian of a quaternary n-ic, equated to zero, represents a surface of the $4(n-2)^{\text{th}}$ order, which is called the Hessian of the surface represented by equating the quantic to zero. The relation of the Hessian to the original surface is also very important. It passes through the double, as well as through the parabolic points of the latter. [Indicatrix.] Every point of a developable surface being parabolic, its Hessian consists of the surface itself together with a second one of the order $3n-8$, to which the name *Pro-Hessian* has been given. The properties of the Hessian are examined at some length in Salmon's *An. Geom. of Three Dimensions*, to which work the reader must be referred for further information on this subject.

Hestia. [Vesta.]

Hesychasts (Gr. ἡσυχαστής, from ἡσυχία, *quiet*). In Ecclesiastical History, a singular class of fanatics, who were established in the fifteenth century in some of the Greek monasteries of Mount Athos. These Quietists pretended to have attained a perfect interior life of devotional repose by intense contemplation. One of their maxims, apparently derived from some of the strange practices of the Indian ascetics, directs the disciple to 'raise his spirit above all vain and transient things, repose his head on his breast, and turn his eyes with his whole power of meditation upon his navel.' Hence these visionaries derived the nickname of Ὀμφαλόψυχοι (Cantacuzenus ii. 38), or Umbilicarii: they were also termed Thaborites, from their notion respecting a divine light inhabiting the heart of the devotee. (Gibbon's *Roman Empire*, ch. lxiii.; Waddington's *History of the Church*, chap. xxvi.)

Hetæria (Gr. ἑταιρεία, from ἑταῖρος, *a companion*). This word is frequently used by classical writers to signify an association of any kind; thus the fraternities of the early Christians are called Hetæriæ. In modern times two celebrated associations among the modern Greeks have assumed the name.

The first was the Hetæria of the Philomusoi, or Friends of the Muses; a society formed for the purposes of education, founded (it is said) by Capodistrias, about 1814: it established schools at Athens and elsewhere, and numbered at one time 80,000 associates. It was dissolved in 1821; but renewed in 1824, when Athens was in the hands of the Greeks. The more famous political Hetæria owes its foundation to the celebrated Rigas, who died in 1798. It was renewed about 1816, extended its ramifications through all Greece, and produced the Greek revolution, begun by Ypsilanti in 1821. (Finlay's *History of the Greek Revolution*, 1861.)

Heteposite. A native phosphate of iron and manganese.

Hetero- (Gr. ἕτερος, *the other, one of two*). As a prefix, or in composition, this term usually indicates *difference*; in opposition to the prefix *homo-*, which indicates resemblance.

Heterocephalous (Gr. ἕτερος, and κεφαλή, *a head*). In Botany, when in composite plants some are male and others female in the individual.

(Gr. ἕτερος, and χρῶμα, *colour*). In Botany, when in a flower-head the florets of the centre or disc are different in colour from those of the circumference or ray.

Heterodox (Gr. ἑτερόδοξος, *of another opinion*). A person who holds opinions different from some standard with which they are compared, is opposed in theological language to *orthodox*, one who holds the right opinion. The standard of orthodoxy in Christian belief by which opinions must be tried, resides, humanly speaking, in the judgment of each particular sect of believers. Each section of opinion consequently regards itself as orthodox; but in this country, that which is commonly called the High Church party, professing to hold more strictly by ancient creeds and formularies, is most in the habit of assuming the appellation. [H y.]

Heterogamous (Gr. ἕτερος, and γάμος, *marriage*). In Grasses, when the arrangement of the sexes is different in different spikelets from the same root, as in *Andropogon*: in Composite plants, where the florets are of different sexes in the same flower-head.

Heterogeneous Attraction. [Affinity, Chemical.]

Heterogeneous Quantities. In Mathematics, quantities incapable of being compared together in respect of magnitude, as lines and surfaces, surfaces and solids, &c.

Heterogenesis (Gr. ἕτερος, and γένεσις, *birth*). This term is defined by Pouchet as the production of a new animal without the intervention of parents, all its primordial elements being drawn from surrounding nature. It is analogous to spontaneous generation, by which process the ultimate structures of animals were supposed to have been derived originally from nothing. This theory was advocated by Oken, and by many of the Latin and Greek writers. Pouchet narrates the conditions under which he considers that animals have been spontaneously produced, in his work *Hétérogénie* (8vo. Paris 1859), in which he details the care which he took to eliminate all substances, e.g. putrescible bodies, water, and air, which might act as vehicles of organic germs. His experiments are unquestionably the most conclusive which have ever been made on the subject.

Heterogyna (Gr. ἕτερος, and γυνή). A tribe of Aculeate Hymenoptera, in which the females are of different kinds; one fertile, the other infertile, called *neuters*, as the ants, Formicidæ and Mutillidæ [see those words].

Heteromerans (Gr. ἕτερος, and μηρός, *a leg*). In Zoology, a term signifying that the legs have a different structure from one another. The Coleopterous insects are so called which have five joints in the tarsus of the first and second pairs of legs, and only four joints in the tarsus of the third pair. Latreille divides this somewhat artificial section into four groups.

1. *Melasomes*, having the wing-covers hard, wings generally wanting, claws simple, and maxillæ with a hook.—Ex.: *Pimeliidæ, Blapsidæ, Tenebrionidæ.*

2. *Taxicornes*, having the wing-covers hard, wings present, antennæ perfoliate or clavate, claws simple, maxillæ without a hook.—Ex.: *Diaperidæ, Cossyphidæ.*

3. *Stenelytres*, having the wing-covers hard and contracted posteriorly, wings present, antennæ simple, claws simple or toothed.—Ex.: *Helopidæ, Cistelidæ*, &c.

4. *Trachelides*, having the wing-covers flexible, wings present, head inserted upon a neck, claws bifid.—Ex.: *Meloe, Mordella, Horia, Lagria*, &c.

Heteropods (Gr. ἕτερος, and πούς, *foot*). The name of an order of Gastropods, comprehending those which have the foot compressed, and in the form of a thin vertical fin; as in the *Carinaria.*

Heteropterans (Gr. ἕτερος, and πτέρον, *a wing*). The name of a section of Hemipterans, comprehending those in which the hemelytra terminate abruptly by a membranous appendage.

Heteroscians (Gr. ἑτερόσκιος, from ἕτερος, and σκιά, *shadow*). An epithet applied by the ancient geographers to the inhabitants of the two temperate zones, because their shadows at midday are always projected in opposite directions in respect of each other; in one case to the north, and in the other to the south.

Heterotropal (Gr. ἕτερος, and τρέπω, *I turn*). A term applied to the embryo of a seed when the former lies across the latter, that is to say, neither pointing to its base nor apex.

Hetman (another form of Hauptmann or headman). A Cossack title for the commander of a regiment. [Cossacks.]

Heuchera (after J. H. Heucher). This genus of herbaceous *Saxifragaceæ* yields the astringent Alum-root, which is the root of *H. americana.*

Heulandite. A mineral formerly classed with the zeolites found in the basalt of the

Giant's Causeway and elsewhere: it is a silicate of alumina and lime, named after the mineralogist, Heuland.

Hewn Stone. That kind of stone which is employed after the whole face has been worked; it differs from block stone in the superior quality of the work upon the surface.

Hexachord (Gr. ἕξ, and χορδή). In Music, a progression of six notes, to which Guido attached the syllables *ut*, *re*, *mi*, *fa*, *sol*, *la*. The hexachord is also called a *sixth*; and is twofold, greater and less. The former is composed of two greater, two less tones, and one greater semitone, making five intervals; the latter of two greater tones, one lesser and two greater semitones.

Hexagon (Gr. ἑξάγωνος, *six-cornered*). In Geometry, a plane figure bounded by six straight lines. When these are equal, the hexagon is regular. The side of a regular hexagon is equal to the radius of its circumscribing circle, a property which has numerous useful applications. The area is equal to the square of the side multiplied into the constant number 2·598076; that is, into three times half the tangent of 60°.

Hexagonal Numbers. *Figurate numbers* of the second order and fourth class; they represent the successive sums of an arithmetical series whose first term is 1 and common difference 4. The n^{th} hexagonal number, therefore, is $n(2n-1)$.

Hexahedron. In Geometry, a solid bounded by six planes. A parallelopiped is a hexahedron whose opposite faces are parallel. The cube, or *regular hexahedron*, is one of the five regular solids, having six equal square faces, twelve equal edges, and eight solid angles, each formed by the meeting of three plane right angles.

Hexameter (Gr. ἑξάμετρος, from ἕξ, and μέτρον, *measure*). The most important species of verse used by the Greeks and Romans. It consisted of six feet, either dactyls or spondees, which might be used indifferently in any part of the verse; with the two exceptions, that the last foot must be a spondee, and the last but one a dactyl. In some instances a spondee is introduced into the fifth foot, or last but one, the line being then termed *spondaic*. But in such cases the fourth foot must be a dactyl. [Foot; Cæsura.] In modern times, several poets of France, England, and Germany have attempted to introduce this measure into the language of their respective countries. It has been cultivated in Germany with great success, as the *Hermann and Dorothea* of Goethe, and many other examples that might be cited, abundantly prove. The spirit of the measure has been admirably caught by Voss in his translation of Homer, and by Eberhard in his poem called *Hannchen und die Küchlein*.

The success of English poems in hexameter verse, whether original or translations, is more doubtful. Recent translators of Homer, in particular, appear to regard the hexameter as a metre not congenial to the English language, which almost invariably imparts to it a jingling anapæstic character. (For the controversy on the subject, see Professor Arnold's *Lectures on Translating Homer*; *Edinburgh Review*, April 1863, p. 360; Lord Derby's *Iliad*, Preface.)

Hexandrous (Gr. ἕξ, and ἀνήρ, *a male*). In Botany, a flower having six stamens.

Hexapla (Gr.). The combination of six versions of the Old Testament by Origen is so called: viz. the Septuagint, those of Aquila, Theodotion, Symmachus, one found at Jericho, and another at Nicopolis. [Biblical History, &c.]

Hexapods (Gr. ἕξ, and πούς, *a foot*). A name applied by Mr. Kirby to a suborder of Apterous insects, including those which have not more than six legs.

Hexastyle (Gr. ἑξάστυλος). In Architecture, temples or buildings with six columns in front.

Hexyl. A hydrocarbon = $C_6 H_{13}$. It is a colourless oily liquid, insoluble in water, but soluble in alcohol and ether.

Hiatus (Lat. *a yawning or gap*). This word has passed into several modern languages. In Diplomatics and Bibliography, it signifies a deficiency in the text of an author, as from a passage erased, worn out, &c. In Grammar and Prosody, it signifies properly the occurrence of a final vowel, followed immediately by the initial vowel of another word, without the suppression of either by an apostrophe. This, in Greek and Latin poetry, was only admissible in certain cases; as where, in Greek, a final long vowel is succeeded by an initial short vowel, and becomes sometimes short by position; or, in Latin, where the *cæsura* [Cæsura] gave an additional force to the first vowel, as in the celebrated line,

Ter sunt conatī īmponere Peliŏ Ŏssam,

which affords an instance of both, the first hiatus being occasioned by the cæsura; the second, an imitation of the Greek prosody. In French the hiatus is carefully avoided; in English less so, although by the more accurate poets it is still regarded as a blemish, except in some instances where a long vowel is followed by a short one. The worst species of hiatus is where the same vowel sound is repeated.

Hibernation. [Hybernation.]

Hibiscus (Lat. hibiscum, Gr. ἱβίσκος). A genus of very handsome plants, belonging to the Malvaceous order, with unusually large and showy flowers. They are numerous in the tropics, where they generally form fine trees; but some of the species are only annual. Of the latter, *H. Trionum* is a commonly cultivated plant, known in the seed-shops under the name Bladder Ketmia. Very few of the species are of any interest. *H. cannabinus*, called Indian Hemp, yields a fibre-like jute. *H. syriacus* is the *Althæa frutex* of shrubberies; *H. Abelmoschus* yields the musk-seed of pharmacy; and *H. esculentus*, the *Gobbo* or *Ochro* of the tropics, bears seed-vessels abounding so much in mucilage as to be a common ingredient in the soups of the hotter climates of the world. These are

now often referred to the genus *Abelmoschus*. *H. Rosa sinensis*, a Chinese plant, is remarkable for the property possessed by its flowers of dyeing black.

Hiccup or **Hiccough** (Lat. singultus). A spasmodic affection of the diaphragm caused sympathetically by irritation of structures supplied by nerves communicating with the phrenic or great diaphragmatic nerve. Hiccup is a common symptom of dyspepsia, hysteria, and various nervous disorders. It is often observed in abdominal diseases when terminating fatally, and is especially a symptom in some forms of hernia.

Hidalgo. A Spanish nobleman of the lower class; literally *hijo d'algo*, son of somebody: in Portuguese, *fidalgo*. It is absurdly derived by B. St. Vincent from *hijo de goto*. The title is now obsolete.

Hide (Ger. haut). This term is limited in commerce to the strong and thick skin of the horse, ox, and other large animals.

Hide of Land. [Hyde.]

Hide-bound. In Arboriculture, applied to trees in which the bark does not swell freely in proportion to the growth of the tree.

Hiera Picra (Gr. ἱερος, *sacred*, and πικρός, *bitter*). A compound of aloes and canella bark made into pills or into an electuary with honey.

Hierarchy (Gr. ἱεραρχία, from ἱερος, and ἄρχω, *I rule*). A general term, comprehending the various ranks and orders of the sacred ministry, whether of angels, according to an ancient opinion, or of the pastors of the church of God upon earth. For the formation of the celestial hierarchy, see Milman's *Latin Christianity*, book xiv. chap. ii.

Hieratic Character. [Hieroglyphics.]

Hieroglyphics (Gr. ἱερογλυφικός, from ἱερος, *sacred*, and γλύφω, *I engrave*). Sculpture-writing or picture-writing; i. e. the expression of a series of ideas by representations of visible objects. The name is more peculiarly applied to a species of writing in use among the ancient Egyptians. [Alphabet.] According to the system of Champollion, the hieroglyphical writing of the Egyptians consists of three different species of characters: 1. The hieroglyphic, properly so called, in which the representation of the object conveys the idea of the object itself; either entire, or in an abridged form. Many words were thus expressed, chiefly those denoting common visible objects. These are termed by Champollion *figurative*, and divided into *figurative proper*, *figurative conventional*, and *figurative abridged*. 2. The second class of hieroglyphical characters consists of those which represent ideas by images of visible objects, used as symbols; and these are generally employed in the expression of abstract ideas or complex modes: as, a *tumult*, represented by a man throwing arrows; *adoration*, by a censer containing incense, &c. In some of these the connection between the type and antitype is obvious; in others, it depends on associations which are not understood by us, and consequently cannot be traced. These characters are what the Greeks more peculiarly termed hieroglyphics: they are called by Champollion *symbolical*. 3. The third class consists of *phonetic characters*, in which the sign represents not an object but a sound. This, according to Champollion, was effected by the following device. The figure representing a letter was the likeness of some animal or other object of which the name began with that letter. Thus Champollion has constructed an alphabet of initials, in which the letter A is represented by an eagle, the initial letter of the Egyptian word *eagle* (Ahorn) being A; and so forth. Twenty-nine elementary sounds were thus represented. But the writer was not confined to the use of one representative of a letter only. At first sight it would appear that all objects, the initial of whose name was a particular letter, might be used to express that letter; but custom seems to have applied only a certain number of objects to this use: some letters have eighteen or nineteen known representatives, others six or seven. The honour of the recent progress made in the explanation of hieroglyphical writing is divided between the English Orientalist, Dr. Young, and the Frenchman Champollion. (*Edinburgh Review*, July 1862, p. 102.) Much progress has been made of late years in the further elucidation of the subject by Dr. Hincks, Sir H. Rawlinson, Lepsius, and Bunsen (*Egypt's Place in History*). Besides the hieroglyphic character, the Egyptians used the *hieratic* and *demotic*, which were, both of them, conversions of the hieroglyphic into a kind of current hand: the latter nearly alphabetical. The most civilised people of America, the Mexicans, at the time of the Spanish conquest, had advanced as far as the discovery of hieroglyphical or picture writing, although they did not possess a written alphabet. The Chinese writing was, originally, wholly ideographic; i. e. expressing ideas by symbols (answering to the second class of Egyptian hieroglyphics, with some admixture of the first). But in process of time the greater part of the characters have become simply phonetic. (See especially the art. 'Hieroglyphics' in the *Ency. Brit.*; also Jablonski, *Pantheon Ægyptiacum*; Seyffarth, *Rudimenta Hieroglyphices*, 1825; Sir G. C. Lewis, *Astronomy of the Ancients*, ch. vi.)

Hierogrammatists (Gr. ἱερογραμματεύς, *a sacred scribe*). The name given to certain Egyptian priests whose duty it was to keep the sacred records, to teach the ritual, and to insure its accurate observance.

Hieromancy (Gr. ἱερομαντία). The art of divination from the appearances presented by the victims offered in ancient sacrifices.

Hieromnemon (Gr. ἱερομνήμων, *an observer of sacrifices*). In Ancient History, the title of one of the two deputies sent to the meetings of the Amphictyonic Council by each tribe composing that confederacy. His office was, as the name imports, to superintend the religious rites on the occasion.

Hieronymites or **Jeronymites.** An order so named from its patron St. Jerome. It originated in Spain, and comprehended religious of both sexes. The Hieronymite convents are usually in mountainous and solitary places, in imitation of the retreat of St. Jerome to his hermitage at Bethlehem.

Hierophantes (Gr. from ἱερός, and φαίνω, *I show*). The title of the priest who initiated candidates at the Eleusinian Mysteries. He was necessarily a citizen of Athens, and held the office, which was regarded as one of high religious importance, for his life. (Meursius *On the Eleus. Mysteries*; Potter's *Grecian Antiquities*, vol. i.; *Mém. de l'Acad. des Inscr.* vol. xxi.)

High Church. In English History, an epithet usually applied to those opinions which tend to exalt the ecclesiastical power, and to the parties which embrace them. According to Burnet (*Time*, vol. ii. p. 249), the term *high church party* began to be used about the year 1700. Those who belonged to it were at that time considered to be unfriendly to the settlement of the nation at the Revolution, and disposed to Jacobite principles. Under Queen Anne, high church principles were for a short time in the ascendency; but after the accession of George I., in 1715, it is difficult to point out any political party which has seriously embraced them. But in matters relating to the discipline of the church itself, a *high church* and a *low church* party, the former attaching more and the latter less value to ecclesiastical dignities and ordinances, have always existed in the establishment of England.

High Commission, Court of. In English History, this court was erected by 1 Eliz. c. 1 as an ecclesiastical tribunal, without power to fine or imprison. The commissioners seem, however, to have committed various arbitrary acts towards the end of that queen's reign. One of their warrants was declared of no authority in 42 Eliz. Under Charles I. it assumed enormous and illegal powers, becoming a court for the trial of all manner of offences which might be construed as ecclesiastical; and was one of the grievances complained of and abolished by the Long Parliament, 16 Ch. I.

High Constable. [Constable.]

High Pressure. A term applied by Engineers to designate the steam which works engines without being condensed at the end of every stroke; it is usually employed at a high degree of elastic force, the pressure per square inch being about 40 or 60 pounds. In American and in some modern English engines, steam of 120 pounds pressure per inch superficial is used. Condensing engines are not usually called high-pressure engines, though they may employ high-pressure steam.

High Treason. [Treason.]

Highgate Resin. A fossil resin discovered on cutting the road through Highgate Hill: it is embedded in the London Clay in detached nodules.

Highness. A title first attributed to bishops, afterwards to European kings in general (succeeded by *majesty* in the sixteenth century), afterwards to sovereign princes and their descendants. The title of *royal highness* was first assumed by the duke of Orleans, brother of Louis XIII., in 1631; and it is now conferred on all royal princes and princesses, whether in the direct line of succession or not. The elector of Hesse Cassel and the grand dukes of Germany have also the title of *royal highness*. The children of the emperors of Russia and Austria, and their descendants, are styled *imperial highness*; and all other princes not included in the above category bear the title *serene highness*, being an equivalent for the term *Durchlaucht*, by which they are addressed in Germany.

Highway. In English Law, a highway is a way over which the public at large have a right of passage, and includes a horse road, or a mere footpath, as well as a carriage road. Any way common to all people, without distinction, is a highway. A public navigable river is also called a highway. The right of the public in a highway is, however, a right of passage over it and nothing more. The soil itself, and all the profits upon it or underneath it, as mines, minerals, &c., and also any strips of waste land lying between the highway and the lands adjoining it on either side, belong to the owners of adjoining lands. But if such strips of waste land be contiguous to or communicate with an open common, they are then taken to be part of the common. A highway may originate from a continual user of land by the public in traversing it without interruption from the owner, or from an express dedication of it by him to their use. A much shorter period of user will establish a right in the public than a right in any private person to a way; the user in the former case being so open and notorious that the owner of the land may fairly be presumed to have had early notice of it, and to have assented to it by not opposing it. Accordingly, a public way may be acquired by an enjoyment for five or six years, although twenty years' enjoyment is necessary in the case of a private way. A highway may also take its origin from statute, or from necessity. A highway originates from necessity when the accustomed line of highway is out of repair so as to be impassable; in which case the public have a right to traverse the adjoining ground.

The duty of keeping highways in repair is cast by the common law upon the occupiers of lands in the parish generally; but particular persons may be liable to repair by prescription or tenure. They may also be liable in respect of enclosure; that is, if a highway be free from fences on either side, and the owner of the adjoining land chooses to fence it off from the highway, he will then be liable in respect of his enclosure, because he has thereby deprived the public of using his land as a way of necessity, in the event of the original highway becoming impassable for want of repair. The omission

to repair on the part of the parish or party liable is an indictable offence, and may be punished accordingly. Various statutes regulated the mode in which the occupiers in a parish were to contribute labour, carts, and cattle, for the purpose of repairing highways, and to perform upon them what was therefore called statute duty; but these purposes are at the present time provided for by a highway rate. Highways are frequently placed by the legislature under the jurisdiction of trustees; such highways are popularly called *turnpike roads.* If sufficient materials for the repair of roads cannot be found on the waste lands of a parish, the surveyors have authority to take them from the lands of any private person (with certain exceptions).

The laws for the regulation of highways were consolidated and amended by the 5 & 6 Wm. IV. c. 50, further amended by 4 & 5 Vict. cc. 51 & 59, and 8 & 9 Vict. c. 71. Formerly, as appears above, if land had been traversed as a way by the public for a few years without interruption, a highway was at once established, and the liability to repair it was cast upon the parish; but by the law as now established no road is to be deemed a highway which the inhabitants of a parish shall be compellable to repair, unless the inhabitants of the parish, in vestry assembled, shall deem it of sufficient utility to them to justify its being kept in repair at the expense of the parish. If the vestry shall not deem it of such utility, the party proposing to dedicate the new highway may be summoned to appear before the justices at special sessions, when the question is to be determined. By stat. 25 & 26 Vict. c. 61, the justices of any county are empowered to form it, or any part of it, into a *highway district*, to be governed by a *highway board*, with the object of securing increased efficiency, by adopting unity of management of the highways.

Hilum (Lat.). In Botany, the scar on a seed which shows the point where it was attached to the placentæ.

Himalayan Chain. This loftiest mountain chain of the earth is the southernmost of several considerable ranges forming the great mountain axis of the Old World. It is generally regarded as consisting of three parts, the Hindu Coosh or Indian Caucasus to the west, the Himalayas strictly so called, and the mountains of Assam, the three together forming a continuous group. The valley of Cashmere separates the two first-named divisions, and the valley of Bhotan the two latter.

The principal mountains of the chain are cut by narrow ravines, and rise from very elevated plains to heights varying from 20,000 to 28,000 feet, with very few practicable passes, and these at great elevations.

The Indus and the Ganges rise within this chain of mountains, and are fed by numerous tributaries proceeding from the higher valleys. Although the snow-line is at an extraordinary height, the principal peaks and highest parts of the valleys are all within it, and the glaciers are few but very extensive. The snow-line is much higher on the north than on the south side, notwithstanding the difference of latitude and the less favourable exposure; but this, no doubt, arises from the clearer state of the air and the radiation of heat from the neighbouring high plains.

Many secondary chains are connected with the main chain of the Himalayas; some of them are extremely lofty and grand, and some are metalliferous.

Cultivation is carried on to a great elevation in the plains and on the mountain sides of this chain. Corn is cultivated at 16,000 feet in Chinese Tartary, and even in some places at 18,500 feet. Tall birch-trees occur at 14,000 feet, and in many parts the climate is much more mild than at far lower elevations under the equator in South America. There are no volcanoes in the Himalayans, but hot springs rise in many parts to the surface.

Himantopus (Gr. ἱμαντόπους, from ἱμάς, *a thong*, and πούς, *a foot*). This name is now restricted to a genus of *Grallæ*, or wading-birds, in which the legs are proportionally longer and more attenuated than in any other species: the bill is long and slender, depressed at the base, and compressed toward the tip, with the nasal groove extending half the length of the bill. This genus includes the British species called the common stilt, or longshanks (*Himantopus melanopterus*). It is an occasional visitor, and a rare bird.

Himyaric Inscriptions. Inscriptions found in Arabia, exhibiting the primitive type of the oldest form of the language still spoken in South Arabia. These inscriptions have been investigated since 1830 by Gesenius, Rödiger, Fresnel, and Ewald.

Hip. The fruit of the Dog Rose (*Rosa canina*). It furnishes the *conserve of hips* of Pharmacy, which is a convenient vehicle as a pill-basis, and for electuaries and linctuses.

Hipparion (Gr. ἱππάριον, *pony*). A fossil genus of *Equidæ*, from the miocene deposits of Eppelsheim and the Sewalik hills in India. These deposits have yielded molar teeth differing from those of existing horses chiefly in the distinctness or greater extent of separation of the interlobal or inner column; and hoofs in which the second and fourth digits (suppressed under the form of splint bones in the existing horse) were retained as in typical *Perissodactyla*, in a functional state.

Hippides. The name under which Latreille and Eichwald designate a family of the tribe of Macrourous Decapod Crustaceans, typified by the genus *Hippa*.

Hippobosca (Gr. from ἵππος, *a horse*, and βόσκω, *I feed*). A genus of Dipterous insects belonging to the Viviparous section of the order, in which the young are not only excluded from the ovum, but undergo their first metamorphosis in the womb of the parent, and are brought forth in the pupa state. (*Pupipara*, Latr.; *Homaloptera*, Leach.) The genus is now the type of a numerous family (*Hippoboscidæ*), generally known by the name

of *forest flies* and divided by recent entomologists into numerous subgenera. The horsefly (*Hippobosca equina*) is the type of the family.

Hippocampus Major. A long curved eminence on the floor of the middle or descending *cornu* of the lateral ventricle of the brain. It follows the direction of the cornu towards its anterior extremity, and is notched, or indented, on its surface. [BRAIN.]

Hippocampus Minor. This structure has also been termed *pes hippocampi minor*; *unguis*; *eminentia unciforme*; *ergot de Morand*; *calcar avis*; *eminentia minor digitata*; *ocrea*; and *colliculus*. It is situated on the floor of the posterior horn of the lateral ventricle, on which it forms 'a longitudinal eminence corresponding to a deep sulcus between two convolutions.' (Gray, *Anatomy*.) No such structure, corresponding in position and shape to the anthropotomist's definition, has yet been discovered in any known ape. (Cruveilhier, Tiedemann, Owen.)

Hippocastanum. The *Horse-chestnut*. [ÆSCULACEÆ.]

Hippocras. Spiced wine. The following is one of the most approved recipes for its preparation: 2 ounces of cinnamon, half an ounce of canella alba, and of cloves, mace, nutmeg, ginger, cardamoms, each 1 drachm: these are to be finely bruised and digested for three or four days, in a warm place, in a mixture of 12 quarts of canary and Lisbon wines: the liquor is then to be filtered, and 3 pounds of refined sugar added.

Hippocrateaceæ (Hippocratea, one of the genera). A small natural order of plants of the Rhamnal alliance, distinguished from *Celastraceæ* by little except the flowers being triandrous, and the filaments broad at the base. There are few species of general interest included in the order. Some species of *Tontelea*, however, produce sweet edible fruit.

Hippocrates' Sleeve (Lat. Manica Hippocratis). An old pharmaceutical term signifying a conical bag or strainer made of flannel or linen, in the shape of a jelly-bag.

Hippocrene (Gr. ἱπποκρήνη, *a horse fountain*). A fountain at the foot of Mount Helicon, supposed to have been produced when the horse Pegasus struck his foot against the mountain. It was regarded with peculiar veneration, as it was believed to be a favourite haunt of the Muses, and was looked upon as one of the chief sources whence the poets drew their inspiration. [MUSES; PEGASUS.]

Hippodrome (Gr. ἱππόδρομος). In Ancient Architecture, a place appropriated by the Greeks to equestrian exercises. The most celebrated hippodromes of antiquity were those of Olympia and Constantinople; the former was four leagues long and one in breadth. The term is still used, to express the arena devoted to spectacles in which horses are made to appear.

Hippogryph. A fabulous animal, represented as a winged horse with the head of a griffin.

Hippomanes (Gr. ἱππομανές, from ἵππος, *a horse*, and μανία, *madness*). The Manchineel belongs to this genus of *Euphorbiaceæ*. It is a tree called *H. Mancinella*, and grows forty or fifty feet high in the West Indian islands, &c. The milky juice is extremely virulent, causing blindness if the least drop, or even the smoke of the burning wood, comes in contact with the eye. Salt water is said to be an efficacious remedy.

Hippopotamus (Gr. ἱπποπόταμος, *the river-horse*). A genus of aquatic Pachyderms, represented at the present time by two species (*Hippopotamus amphibius*, Linn., and *Liberiensis*, Morton), which inhabit the rivers of Africa. The generic characters are four toes on all the feet, inclosed in small hoofs; six molar teeth on each side of both jaws; very large and strong canines, of which the upper ones are nearly straight, the lower ones curved, and working upon each other so as to produce a chisel-edge; four incisors in each jaw, the upper ones short and conical, and bent inwards towards the mouth; the under ones long, cylindrical, and pointing forwards. The hippopotamus lives during the daytime immerged in the waters of its native rivers, rising to the surface and protruding its nostrils for the purpose of breathing: it comes to the land to feed during the night. Remains of species of hippopotamus are found in the tertiary formations of Europe; one of these species hardly exceeding the size of a hog. In the tertiary beds at the base of the Himalaya range, an extinct species of hippopotamus has been discovered which had six incisor teeth in each jaw (*Hexaprotodon*, Falconer).

Hippopus (Gr. ἵππος, and ποῦς, *a foot*). The name of a genus of Acephalous Molluscs, significative of the resemblance which their shell bears to the foot of a horse. The valves of this shell are equal, regular, but inequilateral and transverse; the hinge has two compressed unequal teeth; the ligament is marginal and external. The *Hippopi* belong to the family *Tridacnidæ* of the Lamarckian system; but are distinguished from the genus *Tridacna* by having the posterior slope and lunule closed, or nearly so, and the inner margin dentated at that part. The spines which arm the ribs are tubular, and are never arched or vaulted. The type of the genus is the *Hippopus maculatus*, or spotted hippopus; the *Ostrea hippopus* of Linnæus.

Hippuric Acid (Gr. ἵππος, and οὖρον, *urine*). This acid is contained in the urine of herbivorous mammifera, and in small quantity in human urine, in which it may be produced by the use of benzoic acid, which in passing through the system is converted into hippuric acid. It may be obtained by adding milk of lime to fresh cow's urine, boiling, filtering, neutralising the filtrate with hydrochloric acid, and evaporating it to about one-eighth of its bulk; excess of hydrochloric acid is then added, which throws down impure hippuric acid. It may be purified by dissolving it in boiling alcohol, which on

cooling deposits it in colourless four-sided prisms with pointed terminations. It requires about 500 parts of cold water for its solution; it is abundantly soluble in boiling water and in alcohol, but less so in ether. The composition of this acid is represented by the formula $C_{18}H_{8}O_{5}N + HO$.

Hippuris (Gr. ἵππουρις, *a horse-tail*). The botanical name of the Common Mare's-tail, a native aquatic plant of the dicotyledonous class, chiefly remarkable for its external resemblance to the cryptogamic Horsetails (*Equisetum*).

Hippurite Limestone. An important representative of the cretaceous rocks in the South of France and the Pyrenees, characterised by the large admixture of shells of the family *Rudistæ* among the fossils. The same character is found to prevail in the cretaceous rocks of Greece and the Mediterranean shores. Many genera of *Rudistæ* are found, but the *Hippurites* are the most striking.

Hippurites. A genus of extinct bivalve Molluscs, referred to the extensive group called *Rudistes* by Lamarck. The principal valve of the present genus is of a sub-cylindrical or elongated conical form, traversed by one or more internal longitudinal ridges, and closed by a small sub-circular discoid valve like an operculum.

Hippus (Gr. ἵππος). A spasmodic affection of the iris, occasioning repeated dilatations and contractions of the pupil of the eye.

Hips. In Architecture, the inclined diagonal edges of a roof where the sides intersect; hence a hipped roof is one in which two sides at least must intersect.

Hircin (Lat. hircus, *a he-goat*). A term applied by Chevreul to a liquid fatty matter which may be separated from mutton suet, and gives it a peculiar rank smell, resembling that of a male goat. When saponified, it produces *hircic acid.*

Hiring and Service. In Law, the general rule with respect to hiring and service is, that if there be no special agreement, but a general one without mention of time, the hiring is for a year certain; if the servant continue in his employment beyond that year, a second year is implied, &c. Consequently, if a master dismiss a servant hired generally, the servant is entitled to wages for the current year, unless the dismissal be for such a cause as will legally absolve the master from his contract: e. g. moral misconduct or refusal to obey orders. But in the case of domestic servants the contract is, by general custom, dissoluble by a month's warning on either part, or payment of a month's wages.

Hirsute (Lat. hirsutus, *bristly*). In Botany and Zoology, when an animal or plant is covered with long stiffish hairs.

Hirudineæ. [Leech.]

Hirundo (Lat. *a swallow*). A genus which forms the type of the Fissirostral or wide-gaping Passerine birds of the Cuvierian system. It is now divided into the subgenera *Cypselus*, including the swift and *Hirundo* proper, the chimney swallow (*Hirundo rustica*), sand martin (*Hirundo riparia*), &c. Our British species are occasional visitors, and the heralds, generally speaking, of the summer season, though we see now and then a premature straggler, which has given rise to the proverb, 'One swallow does not make a summer.' Africa appears to be the chief resort of the British species during the winter season. Their disappearance at this season has, it is true, been accounted for on the hypothesis that the swallows passed the winter in a torpid state, submerged in river-heads or other fresh waters. No warm-blooded and quick-breathing animal does or can hybernate under water; and with respect to a bird, it is sufficient to remark that its extra-vascular plumage would be destroyed and decomposed by a six months' immersion. Swallows, like the cuckoo, immigrate to us for the purpose of breeding.

Hisingerite. A hydrated silicate of peroxide of iron, found in Sweden and Germany; occurring in rounded nodules. Named after Hisinger the mineralogist.

Hispid (Lat. hispidus, *rough*). In Botany, a term used in describing the superficial appendages of bodies, to denote their being covered with long rigid hairs, as the stem of *Echium vulgare.*

Hispid. In Zoology, when a surface is rough from minute spines, or very rigid bristles.

Hister. A Linnæan genus of Coleopterous insects, now raised to a family (*Histeridæ*), belonging to the section *Pentamera*, and the subsection *Clavicornes* of Latreille. Many of the species of this family are remarkable for the instructive promptitude and perfection with which they alter their ordinary appearance when alarmed, by drawing in their antennæ and folding up their legs, so as to feign death, and in many cases to assume the appearance of a small black pebble or seed; whence one of the species is called *Seminulum*. It is this habit which probably suggested the generic name, from the Latin *histrio*, an actor. There are about fifty known British species referable to the Linnæan genus, and now divided into the subgenera *Abræus*, *Orithophilus*, *Dendrophilus*, *Platysoma*, and *Hister* proper.

Histology (Gr. ἱστός, *a tissue*, and λόγος). The doctrine of the animal tissues.

Historical Credibility, Law of. The tests for measuring the trustworthiness of any narrative of alleged facts must form the basis of historical science, as distinguished from what is commonly called the philosophy of history. The latter strives to interpret historical phenomena in accordance with psychological or other theories: the former seeks only to determine the truth of facts as they are determined in judicial processes. It is obvious that the importance of this task cannot possibly be exaggerated; and it may also be said with truth that the nature of the work has been clearly recognised only within the present century. A writer like Gibbon, dealing with a

period for the whole of which we may be said to have narratives of contemporary historians, may not feel the want of the criticism which must be applied to the history of periods not known to us in the same way. But the earlier portions of the history of every nation fade away, by the admission of all, into tales which are indefinite and uncertain, or into legends which are manifestly self-contradictory; and it is clear that the tests applied to measure the value of these portions must, if correct, give us the law of historical credibility—a law of universal applicability and admitting of no exception. It seems also clear that the method adopted by even the most accurate writers down to a very recent time could not make us acquainted with any such law. The Homeric tale of the Trojan war is full of miracles and marvels: the heroes who are prominent in it are the offspring of divine and human parents; while the gods mingle visibly in the strife, and wound others or themselves are wounded and bleed. This exquisite tale of Helen and Achilleus, which reappears in germ in Vedic hymns, and is presented to us in more sombre garb in Norse and Scandinavian epics, has been rationalised by Thucydides, the most severely accurate of contemporary historians, into a narrative as trustworthy to all appearance as that of Hallam's *Constitutional History of England*. This result is attained by casting away every portion of the narrative except that which seems to point to national movements or furnish the clue of some political motive; but if the materials cannot be trusted, the rationalised narrative is, of course, as great a fiction as the poetical tale which it is designed to supplant. The early chronicles of England start with the tale of the same Trojan war, and give a long dynasty of British princes in whose veins flowed the blood of Anchises and Priam. The supernatural or marvellous element in these traditions was as distasteful to Milton as to Thucydides; but the rejection of this element left him satisfied with the *caput mortuum* which then remained. 'Those old and inborn kings,' he tells us, 'never any to have been real persons, or done in their lives at least some part of what so long hath been remembered, cannot be thought without too strict incredibility. So far as keeps aloof from impossible or absurd, I refuse not as the due and proper subject of story.' When, however, Niebuhr reconstructed the ancient history of Rome, it was thought that the revolution in historical criticism had at length been accomplished. With vast learning and a marvellous memory, Niebuhr undertook to disentangle the twisted skein from which he felt sure that he could extract a narrative as thoroughly trustworthy as the life of Charlemagne by Eginhard. Knowing that oral tradition is not to be depended on for more than a few generations at most, knowing also the tendency to exaggeration or falsehood which must prevail where there is no written literature to check it, and that an artificial chronology brings the whole narrative for which it has been framed into extreme suspicion, Niebuhr began his work in a spirit of unbounded confidence, and grounded his own claim to authority not only on his acquaintance with really historical documents, but on a certain insight, almost amounting to an instinctive or divining faculty, acquired by one who has devoted himself wholly to the subject. The result was that, while he exhibited the transparently artificial character of the chronology, while he acknowledged the anachronisms and other contradictions with which the story abounded, he yet insisted that he had *discovered* the political history of the regal period, and established the certainty of revolutions which he himself had got at only by inference from traditions and from the manifest incompatibility of the constitution of Servius Tullius with the facts or alleged facts of the later narrative. Nothing could exceed the ingenuity with which this work of reconstruction was effected; but unless the actual evidence of fact could be urged for every single step, the whole process was simply empirical. The extreme impolicy and danger of such a method as Niebuhr's has been pointed out by Sir G. Cornewall Lewis, who, in his invaluable work on the *Credibility of Early Roman History*, has examined the several classes of historical materials, and swept away the plausible fallacies which exaggerate or impair their value. Under his rigid scrutiny, the uncertainty of conclusions based on public monuments, chronology, lists of officers or kings, family chronicles, poems and lays, has been laid bare with a force and a system not attained by any previous writer. The conclusion is perfectly simple. The testimony of contemporary witnesses is the indispensable condition of all genuine history; and the extent of the reliance placed on them must be determined by the same tests which are applied to the testimony of witnesses in a court of law; but in general it is presumed that a man speaking of what he has seen or heard immediately from eye-witnesses is speaking the truth, unless there be some apparent motive for falsehood, or some bias, whether from political feeling or religious enthusiasm, which lessens or destroys his title to credit. We cannot, however, enter here into an examination of the tests which are applied to discriminate between what is true and untrue in the statements of men, as they relate matters falling within or transcending the standard of ordinary experience. The question is one of the highest importance, as on the answer to be given to it depends our belief in the possibility or impossibility of sorcery, witchcraft, and other topics relating to the action of the spiritual and invisible on the visible and material world, which at no very distant day were the subjects of a legislation as inhuman as it was minute and definite. [WITCHCRAFT.] But a few remarks on the various kinds of historical materials will suffice to show how completely we must fall back for the ascertainment of all facts on the one canon by which judicial examinations are guided at the present day.

back, to use the words of Sir G. C. Lewis, on 'the tests by which the reality of modern facts is determined,' and these tests can be satisfied with nothing less than the word of contemporary witnesses whose credibility must be sifted by the rules already stated. The reader who may wish to examine the subject further is referred to Grote's *History of Greece*, part i.; Sir G. C. Lewis, *Credibility of Early Roman History*, and *Astronomy of the Ancients*; Cox, *Persian War*, part ii.; *Edinburgh Review*, July 1862, p. 97, &c.

Historiographer (Gr. ἱστοριογράφος). A professed historian, or writer of histories. It has been a common, although not uniform, practice in European courts to confer the place of public historiographer on some learned man as a mark of royal favour. Voltaire had at one period the title of Royal Historiographer of France.

History (Gr. ἱστορία, from the verb ἱστορέω, *I enquire*). This word is first used in the commencement of the work of Herodotus, which he there calls by the title *Historia*. It is probable that this writer thus fixed the sense in which the word has ever since been used—as applicable, strictly and properly, to the civil history of man, although it has been analogically used to express other branches of investigation, as in the term Natural History, still in use.

Civil history, properly so called, has also been subdivided into several branches: first, according to the class of events or actions which is made the subject of narration; as ecclesiastical, political, and literary: secondly, according to the extent of the subject; as universal history, in contradistinction to the history of particular nations or districts, or to that of individual men, more properly termed *biography*.

In a general view of civil history (if we remember always that such divisions are after all arbitrary), the whole subject may perhaps be conveniently classed under five heads:—

1. The Jewish history, as contained in the Old Testament.

2. The history of the empires and states of antiquity in that portion of the world known to the classical and Jewish historians, and illustrated by classical and Jewish history; viz. Assyria, Persia, Egypt, Phœnicia, and its colony Carthage.

3. Classical history, properly so called; the history of the national affairs and conquests of the Greeks and Romans.

4. The history of those nations and states (chiefly Oriental) which possess annals of their own, independent of classical, Jewish, and modern European literature; China, India, modern Persia, Arabia, and the Mohammedan conquests.

5 Modern European history, including that of the colonies and conquests of Europeans.

1. The Jewish history, as we have said, is to be found in the Old Testament, some Apocryphal books, and in the writings of Jewish authors, as Josephus and Philo, who have investigated the antiquities of their country.

2. Of Assyria, Egypt, Phœnicia, ancient Persia, Carthage, &c., we possess no historical notice except such as is derived, 1. From Jewish or classical authors; 2. From monuments, especially in Egypt. Phœnician historical authors (Sanchoniatho, Berosus, &c.) are referred to by classical writers, and perhaps their works have been in part abridged by them; but we have no actual remains of their compositions on the authenticity of which reliance can be placed. With respect to Persia, much industry has been expended in endeavouring to extract from the histories of modern native writers coincidences with the narrations of Greek and Roman authors; and the recent discoveries of Layard, Rawlinson and others are thought to have thrown much light on this branch of our subject, though their full value is not as yet determined.

3. The poems of Homer are generally regarded as containing the oldest fragments of Grecian history; but from these we can infer little more than the existence of certain towns, or the prevalence of certain customs, at the time in which the poems were composed. An examination of the Trojan legend with the mythology of other portions of the Aryan race, has shown that there is no real ground for theories which connect the war of Troy with the movements of Hellenic colonists in Western Asia, or with any other political causes. [EPIC.] Herodotus is the oldest Greek prose writer. His invaluable history comprises a description of several countries bordering on Greece and the Mediterranean; concise narratives of Egyptian, Persian, and Assyrian history; and a connected account, more or less detailed, according to circumstances, of the history of Greece, both civil and domestic, for about fifty years previous to the invasion of Xerxes, with which his annals close (B.C. about 480). The history of the Grecian commonwealth is pursued in detail by Thucydides and Xenophon for about a century afterwards. After that period our knowledge of Greek domestic history is confined to the incidental notices derived from contemporary writers, and the general compilations of later historians, varying greatly in trustworthiness and authority. [HISTORICAL CREDIBILITY.] Among these may be mentioned, as authors from whom a large portion of our actual knowledge is derived, Diodorus Siculus, the author of a very miscellaneous general history, of which great part is lost, who lived about the age of Augustus; Polybius, whose history is more especially devoted to Roman affairs; Arrian and Quintus Curtius, the historians of the conquests of Alexander; Livy, as to the transactions between Greece and Rome; Justin, the compiler of a brief but useful abridgement of general history; Plutarch, in his *Lives of Illustrious Men*, &c. These writers bring the student down to the period of the subjugation of Greece by Rome; after which all history of

Greek affairs, properly so called, terminates, until the establishment of what is known as the Eastern empire, and we have little knowledge of the state of Greece and the Græco-Asiatic kingdoms in their provincial state.

Ancient Roman history, down to the first Punic War, is chiefly known from the compilations of Livy and Dionysius of Halicarnassus, writers whose credit is rendered extremely doubtful by modern investigation; and, where these fail, from incidental sources. In the History of the Punic Wars, the narrative of Livy is aided by the admirable work of Polybius. From the end of the second Punic War to the dictatorship of Sulla (nearly 150 years), our materials for Roman history are very deficient; the want of contemporary writers being supplied only by later compilations, and by the incidental knowledge derived from writers on various subjects, the course of whose composition led them to touch on past events—of whom the most valuable is Cicero. From the period of Sulla's dictatorship to the accession of Vespasian (nearly 150 years), we have the advantage of a succession of contemporary writers, some of them actors in the events which they describe, and comprising some of the greatest names in literature—Sallust, Cicero, Cæsar, Velleius Paterculus, Tacitus. Yet even here there is one considerable *lacuna*, comprising the last thirty years of the reign of Augustus, as to which our knowledge is scanty. From the accession of Vespasian to the reign of Constantine, a long period elapses, during which our historical acquaintance with the events of an empire then comprising the greater part of the civilised world is vague and defective. Dion Cassius and Herodian are the two best writers on history who can be named in this long interval; the latter, during the short epoch which he illustrates as a contemporary, is full and valuable. After the accession of Constantine, we have abundant materials for history, both ecclesiastical and civil, from the hand of contemporary authors, down to the reign of Justinian in the East and of Theodoric in the West, although the quality of the writers is sensibly degenerated. Perhaps the comparative obscurity and uncertainty into which history is plunged after the last of these two epochs, and the absence of all standard writers after Procopius, render it the best period to fix upon for the arbitrary limit between ancient and modern history. It will be seen from this brief summary that the only periods of any extent as to which we have the assistance of contemporary historians (or original authority, properly so called), in the whole extent of classical history, are—1. As to Greece, from B.C. 500 to B.C. 380; 2. As to Rome, from the dictatorship of Sulla to the accession of Vespasian (B.C. 76 to A.D. 70); and, finally, the reigns of Constantine and his successors.

4. After the downfall of the Roman empire, a long series of revolutions in dynasties and nations followed before Western Europe was parcelled out into the several great countries which, notwithstanding all subsequent changes in political limits, have since subsisted as geographical divisions—Britain, France, Spain, Germany, Italy, the Scandinavian regions. Another period elapsed before the three great countries of Eastern Europe—Russia, Poland, Hungary—were added as distinct members to the family of European states.

From the abdication or deposition of Augustulus and the so-called fall of the Roman empire to the revival of literature (a period comprising in round numbers about eleven centuries), our knowledge of the affairs of Western Europe is derived from a series of writers, in each country, who are usually comprehended under the title of *chroniclers*. A chronicle, or book of annals, is properly a history of which the continuous narrative is so interrupted that each year forms a separate section, and events are thus related nearly in strict chronological order. This is a form very commonly adopted by the historians of the dark ages, of whom the greater proportion were monks. But a great many of the histories of the middle ages are not even in the form of chronicles; they have all the requisites which the most fastidious criticism can require of a regular history.

The Venerable Bede, who wrote in the ninth century, presents us with the first name of true credit and authority among the annalists of England. Of our monkish Latin chroniclers in later times, Matthew Paris is perhaps best entitled to the character of an historian. After the period of the invaluable Saxon chronicle, we have no vernacular English histories worthy of note, with the exception of a few meagre rhyming chronicles, until the revival of letters and discovery of printing. In France, the long collection of native Latin chroniclers presents us with few names of interest after the time of the celebrated Gregory of Tours; but the Crusades called forth, for a short space, an unusual spirit of historical description. When we arrive, however, at the fourteenth and fifteenth centuries, we find among the native French historians two authors, of great value as intimately acquainted with the events of their own times, Froissart and Philip de Comines. The annals of Italy are to be sought in the pages of a long series of chroniclers, from the eighth century downwards, of whom the most valuable are published together in Muratori's great collection. Their works are uniformly in Latin until the thirteenth century. But towards the end of that age the Tuscan dialect was elevated, as it were at a single step, to the rank of a literary language; and the little Tuscan republics produced a succession of historians, many of them remarkable for the purity of their style, and some (as the three Villani of Florence) for their extensive information and historical talent. Germany and Spain, in the middle ages, produced few historical works above the rank of dry chronicles, but the annals of the Scandinavian nations form the

most important part of their early and peculiar literature. The Greek empire produced, also, a series of chroniclers, whose works have been collected in the *Corpus Historiæ Byzantinæ*.

The period known as that of the revival of letters, and the following century, were distinguished by the appearance of several writers of first-rate merit in the department of history. In Italy, Guicciardini; in France, De Thou; in Spain, Herrera; and our own Camden may be added, not without justice, to the number. To follow the progress of history in modern times would be an impossible task. Suffice it to say, that with the advance of literary knowledge and the increase of education, historical writers seem to become more strongly divided into two very different classes: those who furnish contributions towards the history of their own times, especially the writers of memoirs—of which France gave the first examples, and still produces the most numerous; and the historians, more properly so called, who collect, discuss, and criticise, endeavouring to extricate the truth from the mass of former materials. The latter, in our times, has become more peculiarly the province of literary men. Philosophical history, in which the mere narrative of facts is regarded as subordinate to the elucidation of general truths, and too frequently to the establishment of favourite theories, is a modern improvement in the art; and Voltaire is commonly regarded, not without some truth, as the founder of the school of philosophical historians, among whom the highest rank in popularity has been attained and deserved by Gibbon. But it may be said, with truth, that the present century has carried the science of philosophical and of political history very far beyond those which preceded it. The names of Sismondi, Miguel, Thiers, H. Martin, Thierry, Michelet, Hallam, Macaulay, Niebuhr, Schlosser, Ranke, Finlay, Grote, Milman, Cornewall Lewis, and many more, might be cited in proof of this assertion.

5. The history of the more remote Oriental nations, and also of those which derive their religion and civilisation from Arabia, may be conveniently classed apart, as being derived from wholly different sources. Chinese and Indian history form two entirely distinct bodies of knowledge. With regard to that of the Mohammedan nations, it may be observed that it is brought into contact with that of modern Europe in several distinct countries and periods; of which the most remarkable instances are the Crusades, the annals of the Moors in Spain, and the history of the Turkish empire in its transactions first with the Greeks, and afterwards with the other nations of Christendom.

Histrionic Art. The art of acting in dramatic representations is not unfrequently so called, from the Lat. histrio, or hister, *an actor.* [THEATRE.] The word *histrio* is of Etruscan derivation, as was the Roman dramatic art also. (*Mém. de l'Acad. des Inscr.* vol. xxvii.)

Hitch. In Naval affairs, a particular kind of knot, of which there are several, and all of which have more or less the character of nooses. [KNOT.]

Hithe. An old English word, signifying a port, wharf, or minor harbour, at which goods are shipped or landed; Queenhithe on the Thames is an example.

Hitopadesa. In Sanscrit Literature, a *Friendly Instructor* or collection of fables, commonly known as the fables of Bidpai or Pilpay. This collection has circulated chiefly in India; but another portion, under the title *Calila* and *Dimna*, is famous through Western Asia and in Europe.

Hives, Bee (A.-Sax. hyfe). The ingenuity of man has devised a great variety of bee hives, which may be conveniently classified as follows: 1. Those which do not admit of enlargement; as the common straw hive or skep. 2. Those capable of being added to from above; as the ordinary cottage depriving or capped hives. 3. Those capable of being added to from below; as nadir hives. 4. Those capable of enlargement both above and below; as storied hives. 5. Those capable of being increased sideways; as the collateral hives. 6. Those in which each comb is contained in a separate removable frame; as the leaf hive of Huber, or the more recent frame hives. 7. Those intended to afford facilities for observation; as the unicomb and other observatory hives. 8. Those in which the bees are not circumscribed for space; as the American box hives.

As the management of bees in these several hives varies considerably, it will be desirable to speak of each somewhat in detail.

1. *The straw skep*, or hive generally employed in this country, is a familiar example of the first class, viz. those not admitting of enlargement. The method of management generally pursued is very simple. The swarms of one year are allowed to remain for two seasons, or till the autumn of the second year, when the bees are destroyed by the fumes of burning sulphur, and the contents of the hive appropriated. The chief recommendations of this plan are its extreme simplicity and the facility with which it can be carried into operation by unskilled persons. The drawbacks to it are, that it necessitates the destruction of the bees (often of much greater value than the honey obtained), and that it yields only a small amount of inferior honey, mixed with bee-bread, and contained in old dark-coloured brood-comb.

By a slight variation in the mode of management, much better results may be obtained on this system. The young hives of the current season should be destroyed, instead of those which are older. The reasons for this choice are several. As the first swarm is always led off by the old queen, the colony founded by it is usually less prolific than that from which it proceeded, and which is governed by a young queen of the current year.

The comb contained in the young hives is much whiter and more free from bee-bread than that in the old hives; consequently, the honey yielded by it is far purer in quality. The old

hives which are kept for the issue of swarms will answer this purpose for a great number of years in succession.

In this country the single hives are usually constructed of straw. Straw has the advantage of not transmitting the heat of the sun very readily to the interior; but, when hives are properly shaded, it offers no advantages over wood, which is in many other respects far superior.

2. The most simple improvement in bee management consists in the addition of a cap, small hive, or super to the stock hive. For this purpose the latter should have a flat top, which should be perforated with an opening or openings capable of being closed when access to the super is not required. *Depriving hives* may be constructed of straw or wood; but metal slides or lids to close the openings should not be employed, as, from the great conducting power of metal, it becomes cold in winter, and in that condition condenses the moisture of the hive, which, trickling down the combs, renders them mouldy and unhealthy to the bees.

The management of depriving hives is very simple. When the stock becomes numerous and the secretion of honey by the flowers is abundant, the openings in the stock hive are uncovered, and the cap or super which is to be filled with honeycomb is placed over the hive. If the time has been well selected, and especially if the bees are attracted by fixing some pieces of clean empty comb in the super hive, it is generally at once occupied and filled with pure white honeycomb, free from bee-bread or brood, and worth from four to five times the value of ordinary run honey, obtained on the single hive system. Many persons employ bee-glasses instead of straw or wood supers, but the bees do not take readily to glass, even when darkened; and its employment, therefore, is not desirable.

3. *Nadir hives* are those in which room for the storage of surplus honey is added below the stock hive. The circumstance that the bees always convey the honey to that part of the hive farthest removed from the entrance, renders this arrangement one of the least profitable in actual practice; and, consequently, nadir hives are not to be recommended.

4. *Storied hives*, as their name implies, consist of several stories, which can be placed one over the other; they may be either circular, square, hexagonal, or octagonal. The stock hive, or principal portion, should not contain less than 1,600 cubic inches of space. The mode of management is sufficiently simple. When the hive becomes populous in the spring or early summer, the top box is placed over the hive, and communication made between it and the lower box. An additional box is added below the stock box, to prevent the issue of a swarm, which, by the removal of a very large number of working bees, would greatly lessen the honey-gathering powers of the colony. If a swarm of great size, weighing not less than four or five pounds, and consisting of 20,000 to 24,000 bees, is placed in a storied hive, the top box may even be put on, during the first season, as soon as the stock hive is filled with comb. A well-stored super may thus be obtained. This proceeding, however, is not practicable with ordinary sized swarms of three pounds weight, unless two of them are joined together. There is no system of bee-keeping that yields such profitable results as this. Top boxes of pure white virgin honey, weighing from twenty to thirty pounds each, are constantly produced in good seasons, and meet with a ready sale at four times the price of ordinary run honey.

In Ayrshire, where profitable bee-keeping is better understood than in any other county in Great Britain, the storied hives are almost exclusively employed; and from the skill with which they are worked, aided by the meteorological advantages of the district, yield the largest and best honey harvests known in the kingdom. The boxes employed in Ayrshire are octagonal, about fifteen inches in diameter by six in depth. They communicate with one another by long apertures, which may be closed with slides. Four of these boxes constitute a hive. Of these, two form the stock box for the winter. The super or top box, and the lower box, are only added during the honey-gathering season.

5. *Collateral Hives*, in which increased room is given at the sides, were invented many years since by the Rev. Stephen White, and were advocated during the present century by Mr. Nutt. The impossibility of preventing the queen from passing into the side boxes and depositing eggs, which are always accompanied by bee-bread, renders the plan far inferior to the system last described, and it is rapidly passing out of favour amongst the best practical bee-keepers.

6. *Frame Hives.* Hives in which the bees are compelled to build each comb in a separate frame have been long known. The *leaf hive* of the justly celebrated Huber consisted of rectangular frames placed side by side, and closed in at the extreme ends; these formed a perfect hive when in contact; at the same time every single leaf with its contained comb was capable of being readily removed for observation or deprivation of honey. Since the time of Huber, hives in which the frames are made to lift out from the top have been designed by various apiarians in Germany, England, and America; and in the hands of skilled bee-masters they have proved most advantageous, as they place every comb under perfect control, and admit of the performance of many operations, such as rearing of additional queens, the artificial production of swarms, the deprivation of early honey, &c.

The increased expense of *frame hives* over simple storied hives is, however, one drawback to their general adoption; and the greater skill required in their management, and the less marketable form in which the surplus stores are

removed, render them less suited for ordinary bee-keepers than the storied boxes.

7. *Observatory Hives.* Hives intended to afford unusual facilities for observing the actions of the bees are formed of glass. One of these, known as the *unicomb hive*, is so narrow as to admit of the construction of only a single comb; consequently the cells on both sides are visible, and the deposit of eggs by the queen and the rearing of the young are constantly open to observation. Unicomb hives are useless for practical honey-collecting purposes, as they afford no space for extra stores; and, from their construction, the bees necessarily perish during the winter. A permanent observatory hive, in which the bees are open to observation at all seasons, has been designed by Mr. Tegetmeier. It is formed by constructing each side of the hive of four parallel plates of thin glass, placed very close to each other, so as to include three intervening layers of air. As thus constructed, the hive retains its temperature so perfectly, that the bees remain protected from cold even in winter, and they can always be seen.

8. *American Box Hives.* The well-known circumstance that bees often collect enormous stores of honey when building their combs in a large space (as under the roof of a house) has led to the design of hives of immense size. Some employed in America have been as large as sentry-boxes. These large boxes are easily stocked by supporting a hive of bees on a few cross-bars placed in the interior, when the bees rapidly extend the combs below the small hive, often completely filling the box. The plan is not so advantageous as might at first appear, as all the combs contain brood and bee bread, and the honey yielded is consequently always impure, and moreover is not easily obtained without destroying the bees.

The plans followed in preserving honey for use vary considerably.

Top boxes or supers of pure virgin honey should be allowed to remain untouched until required for use, as, if kept in a cool place, the honey will remain in the cells in a liquid condition for many months, retaining also its delicate aroma, which it loses on being drained from the comb.

When it is required to run the honey from new white comb, a very good plan is to cut it up and stand the vessel in which it is placed in boiling water, when the comb melts and rises to the top, and may be removed when cold, leaving the honey in a pure state below. Honey thus heated retains its liquid character for a much longer time than when drained from the comb in the ordinary manner.

With old comb containing bee-bread this plan is inapplicable; and the comb should be cut up, and the honey drained out through a sieve. It is impossible, however, to obtain honey from old comb uncontaminated by some portion of bee-bread, and by the colour of the old brood cells; and, consequently, its flavour and appearance are inferior to those of virgin honey, stored in new comb.

Wax is always regarded by bee-keepers as a product of secondary importance; the quantity contained in the largest hives rarely amounting to more than two pounds in weight. Wax is most conveniently obtained from the old combs by heating them in boiling water, pressing the melted wax through a pointed canvas bag, and allowing it to flow into cold water; it is then collected, and re-melted with a gentle heat.

Bleached or white wax is formed by exposing yellow wax in thin flakes to the action of the sun and air.

Hoard (A.-Sax. heordan). In communities where property is insecure, and government rapacious or capricious, it is a very natural act to secrete such personal or movable property as can be conveniently collected in small compass, and is ordinarily secure from depreciation. The precious metals, and to some extent precious stones, are commodities of this character. They represent great value in small compass, and the precious metals at least are of universal and permanent acceptance. The practice of private hoarding is fundamentally due to a desire for security; and even when governments are just and honest, habits often only traditional, or consequent upon past experience, or even resulting from a morbid secretiveness, will lead individuals to hoarding. To some extent hoarding is compensative to discovery; and as the practice is limited ordinarily to the precious metals, it often forms a regular process by which part of that which the miner collects in order to add to the currency of civilised communities, is steadily restored to the earth from which it was originally taken. In all likelihood the fact that India has been for many centuries the recipient of vast quantities of silver from the western world, but has not till lately experienced any notable rise in prices, is due quite as much to habits of hoarding, as it is to the practice of employing a large amount of silver for purposes of personal ornament. In the middle ages, too, when government meant spoliation, and any evidence of wealth was a perpetual pretext for extortion, persons often buried treasure; and by their neglecting to supply a key to its locality, the treasure, as far as society was concerned, was lost. So constant was the habit, that *treasure trove*, i. e. specie buried and abandoned, was a notable source of crown income, the right to which was generally reserved even in the largest and widest grants. For different but analogous reasons, the buccaneers of the seventeenth century were said to have buried a large portion of their spoils on the coasts and islands of the American continent; and it is often asserted, that during the times of terror in France, and even throughout the era of the Revolution, the émigrés had made similar deposits, and that, either from their dying or by becoming the victims of the Convention before they had communicated their secret to survivors, all trace of the hoard has been lost.

Even, however, where there exists no neces-

sity for hoarding, due to the obvious impulse towards self-preservation, ignorance or habit may lead to the practice. Monarchs used to hoard in order to meet political exigencies. States have hoarded in order to create reserves on which to operate. Individuals have hoarded, either because they were ignorant of the machinery by which their accumulations might become profitable, or from some mad passion of miserly secretiveness.

Among Political Economists, the word *hoard* is used in a special sense. It is applied partly to accumulations of wealth not actually employed for a profit and in the hands of the public; partly, but less accurately, to the reserves of banks. Such accumulations are of great monetary significance. In the first place, they form a fund from which in particular emergencies a supply can be afforded for foreign investment, extraordinary payments, or even for commercial transactions. High rates of interest, joined with sufficient or apparently sufficient security for advances, will often extract these hoards in large quantity for some occasions. It cannot be doubted that on and after the suspension of cash payments, the high rates of profit consequent on some occupations during the Continental war, liberated these accumulations, and kept up in some degree the supply of the precious metals. This utilisation of hoards has been frequently effected on different occasions in France, where the practice of specie accumulation is common. And in the next place, the reserves of banks fulfil, as securities against contingencies, the same purpose of self-preservation which suggests private hoarding.

Money and such substitutes of it as are actually circulated alone affect prices. Hence no hoard will either raise or depress money values. Again, the price of money is determined by all the values which it represents, and is, therefore, relative to all the transactions which are based upon it. But a hoard is not, by its terms, circulating; and therefore, while it may act as a reserve, it can have no influence on money values. As the practice of private hoarding is gradually dying out in England owing to the general facilities for banking, the amount of hoards is being more and more concentrated in the shape of bankers' reserves.

Hoary (A.-Sax. har). In Botany, a term used in describing the superficial appendages of bodies, denoting their being covered with very short dense hairs, placed so closely as to give an appearance of whiteness to the surface from which they grow.

Hobby (a word of doubtful origin). The name of the small nimble horse on which the light cavalry of the middle ages in England were mounted. [HOBILERS.]

Hobilers or **Hoblers** (Low Lat. hobellarii). In England, feudal tenants bound to serve as light horsemen or bowmen; for the word seems to have been of somewhat uncertain employment. The smaller feudal gentry were long styled in France *hobereaux*.

Hock Day, Hoke Day (Ger. hoch, *high*). A festival formerly observed in England on the second Tuesday after Easter, in commemoration of the destruction of the Danes in the time of Ethelred.

Hocus-pocus. A term given to conjurors' tricks, and said to be a corruption from the Latin words *Hoc est corpus* in the office of the Mass.

Hodograph (Gr. ὁδός, *a path*, and γράφω, *I trace*). A curve imagined by Sir W. R. Hamilton (*Proc. of Roy. Irish Acad.* vol. iii.) to illustrate the theory of central forces. It is thus described: Upon the perpendiculars let fall from the centre of force upon the several tangents to the orbit set off, from that centre, distances proportional to the velocities with which the body moves at the points of contact of those tangents. When the law of attraction is that of the inverse square of the distance, the orbit is a conic of which the centre of force is the focus; and by a well-known theorem the locus of the feet of perpendiculars let fall upon tangents, in other words the *pedal* of the orbit, is a circle. On the other hand, it follows from the law of equal description of areas [CENTRAL FORCES] that the product of each perpendicular into the corresponding velocity is constant, so that the hodograph is the inverse of the pedal, and therefore the reciprocal of the orbit. [PEDAL CURVES.] But the pedal being a circle, its inverse must also be a circle [INVERSE CURVES]; so that all orbits of the solar system have *circular hodographs*. Sir W. R. Hamilton, in the memoir above cited, establishes many interesting properties of the hodograph.

Hoe (Dutch, houwer). In Agriculture and Gardening, an instrument for stirring the surface of the soil, cutting weeds up by the roots, and earthing up plants. The hand hoe is a thin plate of iron six or eight inches broad, and sharpened on the edge, fixed at right angles on the extremity of a pole or rod, which serves as a handle. This is called a *draw hoe*, because in the operation of hoeing the instrument is drawn or pulled towards the operator. Another kind of garden hoe has the blade or iron plate fixed on the extremity of the handle, and in continuation of it: and this is called a *thrust hoe*, because in hoeing the operator always pushes the hoe forward. This kind is also called a *Dutch hoe*, most probably from having been first introduced from Holland. In agriculture, hoes of the thrust kind are drawn by beasts of labour, and commonly called *horse hoes*. In general form they resemble a plough; but in stead of the share they have one or more iron blades, or plates with sharp edges, fixed to perpendicular iron rods at their lower extremities. These sharpened plates being drawn through the soil, cut through the roots of weeds an inch or two beneath the surface. Agricultural or field hoes are only used in the case of those field crops which are sown or planted in rows. There are a great many kinds of field

or horse hoes, chiefly differing in the number of blades which are attached to the common frame for stirring and cleaning a greater or smaller number of spaces between the rows of drilled crops at once.

Hoeing. The operation of stirring the surface, cutting off weeds, or earthing up plants with a hoe. In the case of any of these operations dry weather must be chosen, otherwise the result will either be useless or injurious. Plants rooted up by the hoe in wet weather will produce fresh roots and grow again, while plants earthed up under similar circumstances will have the leaves which are covered by the soil decayed by it. In either case also the ground will be hardened by the treading of the feet of men or horses, so as to obstruct the progress of the roots, and to exclude air and water from penetrating through it to them. Hoeing is sometimes performed on surfaces which are without weeds, for the purpose of stirring the soil; but in such cases pronged hoes, or hoes having three or more long spikes or teeth, are more effective than hoes with broad plates or blades.

Hog. In Naval affairs, a brush with a stout long handle, used for scouring barnacles and weed off a ship's bottom.

HOG. In Zoology. [SUS.]

Högauite. A mineralogical synonym of a species of *Natrolite* from Högau, near the lake of Constance.

Hoggets. Yearling sheep. A lamb becomes a *teg* in its first winter, and afterwards a *hogget*; and, on losing its coat, a *shearhog*.

Hogging. In speaking of a ship, this term has reference to an undue falling of her head and stern, in consequence of weakness in the keel or in the tie provided by the decks. Hogging may be immediately caused by the suspension of the ship on a wave amidships, or by her taking the ground.

Hogmanay (said to be from the Norman-French au gui menez, *lead to the mistletoe*). The old name of the last night in the year, among the Scotch, with whom it was a notable festival. (Lockhart's *Life of Scott*, chap. xliii.)

Hogshead. An ancient measure of capacity, containing sixty-three old wine gallons.

Hoist. This name is given to the machinery applied in factories, mines, hotels, &c., for the purpose of raising men, or things, from one level to another; the man-engines are a kind of *hoist*, as are the hydraulic cranes now generally used.

Holcus. One of our wild grasses, of little value in an agricultural point of view, the herbage being soft and poor. One of the species, *H. lanatus*, goes by the name of White Fog amongst farmers.

Hold (Sax. healdan). The inside of the bottom of the ship. It is divided into compartments by bulkheads across; and contains the ballast, water, coals and wood, provisions and cargo.

HOLD. In Music, the same as PAUSE [which see].

Holidays. This term now denotes practically those days, exclusive of Sundays, on which no regular public business is transacted at public offices. They are either fixed or variable, and vary in different public offices. The variable holidays are Ash Wednesday, Good Friday, Easter Monday and Tuesday, Holy Thursday or Ascension Day, Whit Monday and Tuesday. [FERIÆ.]

Holiness. The title by which the Pope is addressed; equivalent to the Latin *sanctitas*.

Hollow Bastion. In Fortification, a bastion in which the terreplein is limited by a line parallel to the scarp, and along which the interior slope of the rampart extends continuously.

Hollow Revetments. [REVETMENTS.]

Hollow Shot. Empty shells, with metal screw plugs, sometimes used in the navy.

Holly (A.-Sax. holegn). The *Ilex Aquifolium* of botanists, of which many beautiful varieties are cultivated as ornamental shrubs. The Holly is one of the most useful of evergreens for garden decoration.

Hollyhock. A popular flower of the late summer season, whose tapering flower spikes, well placed in a garden, have a very fine appearance. The garden Hollyhocks are varieties of *Althæa rosea*, and one or two closely related species, as *chinensis* and *ficifolia*.

Holm (A.-Sax.). An island, or fenny place surrounded by water. Two well-known islands in the Bristol Channel are called the Steep Holm and Flat Holm.

Holm Oak or **Holly Oak.** [QUERCUS.]

Holmesite. A mineral identical with Clintonite, named after Holmes, who analysed it.

Holocaust (Gr. ὁλόκαυστος, from ὅλος, *whole*, and καίω, *I burn*). A solemn sacrifice among the ancients, in which the whole of the victim was consumed upon the altar, in contradistinction to the usual custom of burning only a portion. A similar custom prevailed among the Jews; it is called in the books of the Old Testament a *whole burnt offering*.

Holocephali (Gr. ὅλος, and κεφαλή, *head*). An order of fishes, distinguished by the following characters: jaws bony, traversed and encased by dental plates; endoskeleton cartilaginous; exoskeleton as placoid granules; most of the fins with a strong spine for the first ray; ventrals abdominal gills laminated, attached by their margins; a single external gill aperture. Only two genera (*Callorhynchus* and *Cestracion*) are known to exist at the present day. The fossil species range from the bottom of the oolitic series of rocks to the present period.

Holograph (Gr. ὅλος, and γράφω, *I write*). In the Civil Law, a will written entirely by the hand of the testator.

Holothurians (Gr. ὁλοθούριον). The name of the family of Echinoderms, having the genus *Holothuria* for its type. The body presents a subcylindrical elongated form; is defended by a coriaceous not spiny integument, open at both ends, and perforated by numerous small canals, in linear series, through which prehensile and

adhesive suckers are protruded. At the anterior extremity is the mouth, surrounded with complicated retractile tentacula. At the opposite end is the aperture of the cloaca, in which the rectum and a respiratory branched tube terminate. The intestine is very long, and convoluted; and it frequently happens that when the animal is disturbed, it is protruded from the body or ruptured by the violence of the contraction of the muscular parietes of the abdomen. The *trepang* of Eastern commerce is a dried species of *Holothuria*.

Holt (A.-Sax. *a wood*; Ger. holz). The termination of many names of places in England, derived from their ancient situation in a wood.

Holy Alliance, The. A league fo med between certain of the principal sovereigns of Europe, after the defeat of Napoleon at Waterloo: on the proposal, it is said, of the Russian emperor Alexander. It arose from the religious enthusiasm which was prevalent at that period of deliverance from French domination, and with which the czar was just then considerably imbued. The act of this alliance is said to have been sent in his handwriting to the emperor of Austria and the king of Prussia, and signed by them. It is not supposed that the original terms of the league were other than indefinite; for the maintenance of justice, religion, &c. in the name of the Gospel. But it was subsequently connected with the determination of those monarchs to support, in conjunction with England and France, existing governments throughout Europe, by the Declaration of November 1819. Afterwards the congresses of Troppau, Laybach, and Verona established the character of the alliance, to which the war of France against Spain, in 1823, gave additional illustration. But England may be said to have finally abandoned its principles in 1827, France in 1830.

Holy Rood or **Holy Cross.** A festival kept on September 14, to commemorate the exaltation of the Holy Cross. It is from this circumstance that the royal palace in Edinburgh has derived its appellation.

Holy Stone. A soft stone used for scouring the decks of ships.

Holy Thursday or **Ascension Day.** In the Roman Calendar, the 39th day after Easter Sunday. A festival in commemoration of Christ's ascension.

Holy Week. The last week in Lent, called also in England *Passion week*, as the period of our Lord's sufferings and death.

Homage (Lat. homagium or hominium, from homo, *man*, the usual term by which the vassal or dependant of a prince is designated in the older writers of the middle ages). The symbolical acknowledgment of dependence due from a vassal to a feudal lord or superior when invested with a fief, or obtaining it by succession. In the earliest periods of the feudal system, fealty and homage appear to be confounded (Sir F. Palgrave *On the English Commonwealth*, vol. ii. p. cccxc.); but in later times the distinction was clearly established, and fealty might sometimes be due where homage was not. Homage was either homagium ligeum, *liege homage*, by which full and unreserved allegiance was rendered; or homagium non ligeum, *simple homage*, a mere acknowledgment of feudal superiority, with a saving or exception of the rights of other feudal lords. The one was personal, and could not be renounced (hence the doctrine of *allegiance*); the other bound the vassal only so long as he held the fief in respect of which it was due.

Homaliaceæ (Homalium, one of the genera). A natural order of arborescent or shrubby epigynous Exogens, inhabiting the tropics. According to Brown they are related to *Passifloraceæ*, but distinguished by their inferior ovary. Lindley places them between *Lauraceæ* and *Cactaceæ*, in the Cactal alliance; De Candolle between *Samydaceæ* and *Chailletiaceæ*. They are plants of some beauty, but of no particular use.

Homberg's Phosphorus. Fused chloride of calcium, which is luminous in a dark place after having been exposed to the solar rays.

Homberg's Pyrophorus. [PYROPHORUS.]

Homberg's Sedative Salt. Boracic acid, to which Homberg erroneously assigned sedative powers.

Home. In Naval language, this term is used of anything that is close in its place; it is applied to the sheets of the sails, the shot and cartridge in a gun, and any article of stowage.

Homeric Poems. This title is generally given to the *Iliad* and *Odyssey*, and the hymns which have been preserved to us in honour of Apollo, Dionysus, Hermes and other Hellenic deities and heroes. But the poems which have come down to us are only a small portion of the treasures which were possessed by the Greeks of the age of Pisistratus or Pericles. [CYCLIC POETS.] The ILIAD relates the events of a few months in the Trojan war, which was caused by the theft of Helen by Paris, once called Alexandros: the ODYSSEY gives the narrative of the return of Odysseus or Ulysses from Ilion to Ithaca. An examination of these two poems seems to show that the groundwork of the tale is in each case the same, and that this groundwork is common to the epic poems of other nations, as the Volsunga Saga, the Nibelungen Lied, &c. Hence a presumption arises that these poems were the result of a very gradual growth, and that in them are combined several lays or poems written by several writers. [EPIC.]

Homicide (Lat. homicidium, from homo, and cædo, *I kill*). In Law, the killing of any human creature; which is either justifiable: viz. 1. In case of necessity, public or private; 2. By permission of law for the advancement of justice; 3. For the prevention of forcible and atrocious crime. Or excusable: 1. By misadventure; 2. In self-defence on a sudden affray, or chance-medley. Or felonious: of which the species are: 1. Self-murder; 2. Manslaughter, which is defined 'the unlawful killing of another without malice, express or

implied;' 3. Murder, or the wilful killing of another by malice aforethought; 4. Petit treason, which by the Statute of Treasons was confined to the cases of a servant wilfully killing his master, a wife her husband, or an ecclesiastical person his superior; but the distinction in judgment between this offence and murder is now abolished. In the law of France, homicide is of four sorts: assassinat, meurtre (corresponding respectively to our murder and manslaughter), accidental homicide, and homicide committed in self-defence.

Homily (Gr. ὁμιλία, *an assemblage*). Used by the early fathers in the same sense as our word *sermon*. Up to the fifth century the practice of preaching was confined to the bishops, and the only homilies extant are of their composition. The term, which has now become obsolete, was in constant use as late as the Reformation; and the English Book of Homilies is a collection of sermons, setting forth the principal doctrines of Christianity, and pointing out the principles of Protestantism; of which the first part was published by Cranmer in the reign of Edward VI., and the second by order of convocation in that of Elizabeth.

Hominy. A kind of meal prepared from maize or Indian corn.

Homo- (Gr. ὁμός, *one and the same*). A prefix used in composition to denote *resemblance*, and thus opposed to *hetero-*, which indicates *difference*.

Homochromous (Gr. ὁμόχρωμος, *of one colour*). In Botany, when all the florets in the same flower-head are of the same colour.

Homœokephalic Representation (Gr. ὅμοιος, *like*; κεφαλή, *head*). This term is used by Professor J. Aitken Meigs to denote skulls belonging to a particular type of men, which repeat analogically the characters of another type with which they have no direct connection, e. g. between the Awares and the Peruvians, or between the Bosjesman and the Mongolian races. The occasional developement of an *interparietal* bone, formed by the ossified elements of the upper half of the super-occipital, both in the old Aymará skulls on the borders of Lake Titicaca and in many other races of men, forms an example of homœokephalic representation.

Homœomeria (Gr. ὁμοιομέρεια, *similarity of parts*). The name given to the physical theory of Anaxagoras of Clazomenæ, who flourished in the fifth century B. C. According to this hypothesis, every material substance is made up of infinitely small parts similar to itself. This theory bears some resemblance to that of the *monads* of Leibnitz in modern times. [MONAD.]

Homœopathy (Gr. ὅμοιος, *similar*, and πάθος, *feeling or affection*). The homœopathic method of healing diseases was first proposed by Samuel Hahnemann, a German physician, in 1796. It consists in the administration of medicines which are presumed to excite in healthy persons symptoms similar to those of the disease which is to be treated, upon the principle that *similia similibus curantur*. Thus it is maintained that sulphur produces a pustular eruption upon the skin, and therefore cures pustular eruptions; and that quinia produces febrile symptoms, and therefore cures agues, and so forth. Not the least remarkable part of this practice is the smallness of the doses in which the homœopathic remedies are administered, it being presumed that by infinite subdivisions the virtues of remedies are proportionately refined and exalted. A grain, for instance, of any active remedy, such as aloes, is triturated with 1,000 grains of sugar of milk; when this mixture is complete, a grain of it is again diluted with 1,000 of the vehicle; and so of medicines which the ordinary practitioner administers in doses of one or two grains or more, the homœopathist prescribes a millionth or the decillionth of a grain, or even less.

Homœozoic Belts (Gr. ὅμοιος, and ζῶον, *animal*). These tracts, defining the boundaries of the geographical provinces of marine animals, are bounded by climatal lines; which are not, however, parallel with lines of latitude, but undulate in subordination to climatal influences of warm or cold oceanic currents, relations of land to water, &c. Of these belts Professor E. Forbes has defined nine; one equatorial, with four to the north and four to the south, which are mutually representative.

Homogamous (Gr. ὁμόγαμος). In Grasses, when all the florets of the spikelets of the same individual are hermaphrodite; in Composite plants, when all the florets of a flower-head are hermaphrodite.

Homogeneous (Gr. ὁμογενής, *of the same kind*). Homogeneous bodies are those of which the constituent elements are all similar. Homogeneous quantities are such as can be added to or subtracted from each other.

Homogeneous Function. In Algebra, a function of two or more variables, such that the result of substituting in it tx, ty, tz, &c. . . . in place of x, y, z, &c. . . . respectively, is equivalent to the multiplication of the original function by a power of t. Thus

$$u_n = F(x, y, z, \&c. \quad .)$$

is called a homogeneous function of the n^{th} degree when

$$F(tx, ty, tz, \&c. \dots) = t^n F(x, y, z, \&c. \dots),$$

where n may be positive or negative, integral or fractional. Differentiating the above equation according to t several times successively, and putting, finally, $t=1$, important theorems, due to Euler, are readily deduced. The two simplest of these are:

$$nu_n = x\frac{du_n}{dx} + y\frac{du_n}{dy} + z\frac{du_n}{dz} + \&c.$$

$$n(n-1)u_n = x^2\frac{d^2u_n}{dx^2} + y^2\frac{d^2u_n}{dy^2} + z^2\frac{d^2u}{dz^2}$$

$$+ 2yz\frac{d^2u_n}{dydz} + 2zx\frac{d^2u_n}{dzdy} + 2xy\frac{d^2u_n}{dxdy} + \&c. \dots$$

whence the general law is evident. In modern

algebra, a rational and integral homogeneous function of the n^{th} degree in m variables is called an m-ary n-ic. [QUANTIC.]

The operative symbol

$$\nabla = x\frac{d}{dx} + y\frac{d}{dy} + z\frac{d}{dz} + \&c.$$

has been termed by Carmichael (*Cambridge and Dublin Mathematical Journal*, vol. vi.) the *index symbol* of homogeneous functions. It is obvious, from the above, that

$$\nabla u_n = nu_n, \ \nabla\nabla u_n = \nabla^2 u_n = n^2 u_n,$$

and generally that

$$f(\nabla)u_n = f(n)u_n.$$

For further consequences of this, see also Boole's *Differential Equations*.

Homogens (Gr. ὁμογενής). A name once given to a group of Exogens, which have their wood arranged in the form of a series of wedges instead of concentric circles. This condition is seen in the stems of Peppers, *Aristolochias*, &c.

Homographic. A term of modern geometry, introduced by Chasles (*Géométrie Supérieure*), and applied originally to two geometrical figures so related that to any point in one corresponds but one point in the other, and vice versâ; whilst to points, in lineâ, in either figure correspond collinear points in the other. The following special applications of the term are important.

Two rows of points, no matter whether they are in the same line or in distinct lines, are said to be *homographic* when the relation between them is such that each point in the one line determines and is determined by one, and only one, point in the other. (Chasles, *Comptes Rendus*, December 24, 1855.) If m and m_1 be corresponding points of two such series, and i and j_1 two fixed points in the respective lines, then, in virtue of the above definition, the following relation will exist between the distances im and j_1m_1:

$$\mathrm{A}\,.\,im\,.\,j_1m_1 + \mathrm{B}\,.\,im + \mathrm{C}\,.\,j_1m_1 + \mathrm{D} = 0 \quad (1),$$

where A, B, C, D, are numerical constants which will be determined as soon as three pairs of corresponding points have been chosen. If we suppose i and the infinitely distant point in the first row to correspond, respectively, to the point at infinity and to j_1 in the second, then the above equation takes the simpler and very convenient form $im\,.\,j_1m_1 = k$, where k is a constant still to be disposed of. From this it may readily be shown that two homographic rows of points or *divisions*, as they are sometimes called, *correspond anharmonically*, that is to say the anharmonic ratio of any four points of the one is equal to that of the four corresponding points of the other; symbolically, $(abcd) = (a_1b_1c_1d_1)$. When two homographic divisions are superposed, there are in general two points e and f; each of which, considered as a point of either series, coincides with its corresponding point; these are called the *common points* of the two rows; they will be real or imaginary according to the nature of the constant k; in all cases, however, they are equidistant from the middle point of the segment ij_1, and in virtue of the anharmonic correspondence of the two series we shall have $(abef) = (a_1b_1ef)$ or $(aa_1ef) = (bb_1ef) = \&c.$; that is to say, the anharmonic ratio of the common points and any pair of corresponding points has a constant value. Hence, if a single pair of corresponding points are harmonic conjugates with respect to the common points e and f, every other pair will be so; and this will occur whenever the divisions are so superposed that the points i and j_1 coincide, or, which amounts to the same thing, whenever a point m, regarded as a point of either series, corresponds to the same point n, for then $(mnef) = (nmef) = -1$. [HARMONIC ROW OF POINTS.] In this case the corresponding points of the superposed homographic divisions form an *involution* of the second order [INVOLUTION], of which e and f are the *double points* or *foci*, and o, or the middle point of ef (with which i and j_1 now coincide), is said to be the *centre*.

It is evident that any row of points and the row formed by projecting the latter on any other line are homographic, and conversely that two homographic divisions may be so placed as to be projections one of the other. On this account the term *projective*, first proposed by Steiner, is frequently used in place of *homogr*[illegible]

The term *homographic*, as applied to two pencils whose elements consist either of right lines, planes, curves, or curved surfaces, has a precisely similar definition; that is to say, two pencils are said to be homographic when the relation between them is such that each element of one pencil determines and is determined by one, and only one, element of the other. It can be readily shown that the elements of homographic pencils correspond anharmonically. To do so in the case of curves, it is only necessary to remember that the anharmonic ratio of any four curves of the pencil is identical with that of the pencil of tangents to these curves at any one of the fundamental points through which they all pass. [PENCIL.]

The term *homographic* is also frequently applied to two geometrical systems whose elements are dissimilar; thus, a pencil of rays and the row of intersections of these rays by a transversal are said to form homographic systems. In this case, however, Chasles would simply say that the systems correspond anharmonically.

The numerous researches of Steiner, Chasles, De Jonquières, Cremona, and other cultivators of modern pure geometry, abundantly prove the importance of the theory of homographic relations. Recent continental mathematical publications, indeed, will be unintelligible unless the reader bring to their perusal a knowledge of the elementary parts of the theory above sketched. Amongst the English works to be consulted on the subject are Salmon's *Conics*, Mulcahy's *Principles of Modern Geometry*, and Townsend's *Chapters on Modern Geometry*. On

the Continent the best works are those of Chasles, *Aperçu Historique* and *Géométrie Supérieure*, &c.; De Jonquières, *Mélanges de Géométrie Pure* and *Essai sur la Génération des Courbes Géométriques*; Steiner, *Systematische Entwickelung der Abhängigkeit geometrischer Gestalten*; Möbius, *Barycentrische Calcul* (in which the term *collinear* is used in place of *homographic*); and Cremona, *Introduzione ad una Teoria Geometrica delle Curve Piane*, Bologna 1862.

Homologation (Gr. ὁμόλογος, *agreeing with*). In Civil Law, the act whereby a competent tribunal recognises and sanctions the acts of private individuals or of an inferior authority. Thus a composition with creditors requires in France homologation by the Tribunal of Commerce.

Homologous (Gr. ὁμόλογος). A term applied in Euclid to the antecedent, as well as to the consequent, terms in proportionals (book vi. def. 12). Homologous sides in similar figures are those which occupy corresponding positions with respect to the equal angles.

Homologous Series. Groups of chemical compounds, the formulæ of whose members differ from each other by two equivalents of carbon and two of hydrogen, or a multiple of that number. The alcohols, ethers, fatty acids, and organic bases are examples of homologous series.

Homology (Gr. ὁμολογία, *agreement*). In Anatomy, that department of the science which teaches the essential correspondence of parts, either in different animals, or in different segments of the same animal, or in the same segment, and also the correspondence of the parts of an animal with the ideal archetype which has governed the plan of its organisation. Thus, firstly, the wing of a bird is, homologically, the same limb as the arm of a man or the forefoot of a horse; and the *os quadratum* of a bird is shown to be the same bone as the *os tympanicum* of the tortoise, and as the *auditory process of the temporal bone* of a man. They are said to be *homologous* parts, and the propositions are examples of what has been called *special homology*. Secondly, the wing of a bird is the same or correlative part in its segment of the body, as the leg is in a more posterior segment; just as the frontal bone is the correlative element in its segment, with the superoccipital bone in its segment. The wing of the right side is also the answering part of the wing of the left side; in the same way that the right neurapophysis of any given segment answers to the left neurapophysis in the same segment. Propositions of this kind are examples of what is termed *serial homology*; and the parts so corresponding are said to be *homotypal*; thus the arm is the homotype of the leg, the humerus of the femur, the radius of the tibia, the ulna of the fibula, &c. Thirdly, in relation to the archetype of the vertebrate skeleton, the arm is the *diverging appendage* of its segment; the superoccipital bone is the *neural spine*; the exoccipital bone or *condyloid part of the occipital bone* in Anthropotomy is the *neurapophysis*; the basioccipital bone or *basilar process of the occipital bone* is the *centrum* or *body* of its segment: these propositions are instances of what is termed *general homology*, as being expressive of the highest generalisations in that philosophical department of anatomical science. (Owen *On the Archetype and Homologies of the Vertebrate Skeleton.*)

Homomorphous (Gr. ὅμος, and μορφή, *form*). In Botany, applied when bodies of the same order are uniform, or shaped alike.

Homonymous (Gr. ὁμώνυμος, *of the same name*). In Anatomy, this term is synonymous with *homotypal*. 'If those of the right side arise from the left part of the brain, and vice versâ, which seems to be the opinion of the best anatomists, then one would imagine that the homonymous nerves of the right and left side must, in crossing over, lie somewhere contiguous to each other, and so impart vibrations to each other.' (Hartley.)

Homonyms (Gr. ὁμώνυμος). Words which agree in sound but differ in signification, as the noun *bear* and the verb *bear*. [Polyonymy.]

Homoousians and Homoiousians. Names by which the Orthodox and Arian parties were distinguished in the great controversy in the fourth century upon the nature of Christ; the former word signifying that the nature of the Father and Son is the *same*, the latter that they are *similar*. [Arians.] (Milman's *Hist. of Christianity*, ii. 443.)

Homophonous (Gr. ὁμόφωνος, *of the same tone*). In Music, of the same pitch, or unisonal. Two or more sounds are said to be homophonous when they are of exactly the same pitch.

Homophony. Homophonous words or syllables, in Language, are words or syllables having the same sound, although expressed in writing by various combinations of letters. Languages which abound in homophonies are, 1. Some Oriental monosyllabic tongues, namely, the Chinese and its kindred dialects, in which very few sounds comprise the whole vocabulary, and the same sound is expressed by a variety of ideographic characters; in Chinese there are only 400 such sounds, multiplied by the distinctions of tone and accent to 1,600 or 2,000; and, 2. Some European tongues in which, according to the genius of the dialect, the syllables of the original languages from which the words are chiefly derived have been contracted in speaking, and part of their sounds dropped, while the greater part of the letters is retained. Thus in English, and still more in French, which is peculiarly a dialect of Latin abounding in contractions, homophonies are numerous; in the latter tongue the number of syllables differently spelt, all having nearly the sound of our broad A, amounts to more than a hundred; while in Italian, in which the original proportions of the Roman language are preserved, they are scarcely to be found.

Homopterans (Gr. ὁμόπτερος, *of the same plumage*). The name of an order of insects, dis-

membered from the *Hemiptera* of Linnæus, including those in which the wing-covers are of a uniform semi-membranous consistency. Latreille divides this order into the three following divisions: viz.

1. The *Cicadariæ*, having the tarsi three-jointed, and the antennæ very short, terminated by a fine bristle.

2. The *Aphidians*, having the tarsi two-jointed, and the antennæ longer, without a terminal bristle; containing the families *Aphidæ* and *Psyllidæ*.

3. The *Gallinsecta*, having the tarsi one-jointed, terminated by a single claw. The males have two wings, and are destitute of a mouth; the females are wingless, and furnished with a sucker.

Homotropal (Gr. τρέπω, *I turn*). In Botany, a term used in describing the direction of bodies, to denote any one having the same direction as the body to which it belongs, but not being straight.

Homotype (Gr. τύπος). In Anatomy, the correlative in one segment with any given part in another segment, or in the same segment, of one and the same animal. Thus the frontal bone is the homotype of the superoccipital bone; the humerus is the homotype of the femur; the parts on the right side are homotypes of those which are repeated on the left side. It is the object of *serial homology* to determine *homotypal* parts. [HOMOLOGY.]

Honey (Ger. honig). A sweet liquid secreted by many kinds of flowers, and collected by the honey bee: the portion not required for their food is returned into the combs in the form of a yellow syrup, the qualities of which differ according to the flowers whence it has been derived. In its original liquid state it probably resembles uncrystallisable sugar of fruits, &c.; but when kept for some time, a large portion of it passes into a granular form. Honey also contains a little wax, gum, colouring matter, and mannite. [HIVES.]

Honey Dew. A sugary clammy secretion, formerly regarded as being formed by the leaves of plants in hot weather. It appears to be secreted by *Aphides*, and is sometimes so abundant as to fall from the leaves in drops. It is greedily collected by the honey bees, and its recurrence several times during the same season adds greatly to the amount of honey collected by these insects.

Honey Locust. The *Gleditschia triacanthos* of botanists.

Honey Stone. A yellow mineral found in octahedral crystals at Artern in Thuringia. It is extremely rare. It consists of a peculiar acid (mellitic acid) combined with alumina and water.

Honeysuckle. The common name of the plants belonging to the genus *Lonicera*, well-known fragrant climbing shrubs, of which two species occur wild in this country. Agriculturists sometimes apply the same name to Meadow Clover, *Trifolium pratense*. The Honeysuckle of Australia is a tree of the proteaceous family, the *Banksia serrata* of botanists; and what is called French Honeysuckle is *Hedysarum coronarium*.

Hong. The Chinese name for the foreign factories situated at Canton. The hong merchants alone were legally permitted to trade with foreigners until the treaty with China of 1842. The restriction is now abolished by art. 5 of that treaty.

Honorarium (Lat. from honos, *honour*). A term used almost synonymously with *fee*, and applied at present chiefly to the fees tendered to professors in universities, and to medical or other professional gentlemen for their services. It was originally applied solely to the salaries of the great officers of state, whose services it was considered were remunerated only, as it were, *honoris causa*; a shade of meaning which is still perceptible in the present use of the term.

Honour (Lat. honor). In Law, this word signifies the more noble sort of seigniories, on which other lordships or manors depend by the performance of customary services.

The term *honour*, in its common sense, is susceptible of various significations; all of which, however, may easily be traced to its original meaning, *esteem or regard built on opinion*. Among the Romans honour was deified; and in modern times the term is used to indicate certain rules by which society in general, and especially that portion of it called *fashionable*, has tacitly consented to regulate its proceedings, any deviation from it being attended by expulsion from its pale. To this class may be referred, with slight modifications of meaning, the phrases *debt of honour*, *law of honour*, *court of honour*, *affair of honour*, &c., which are all self-explanatory. The term was formerly the style of a man of rank generally; but it is now distinctively conferred on the Vice-Chancellors and the Master of the Rolls.

Honour, Legion of. [LEGION, &c.]

Honours. The compliments paid by troops to royalty, officers of rank, &c.; and at military funerals to all grades of the army. A scale of honours is laid down in the queen's regulations.

Honourable. A title prefixed to the Christian names of the younger sons of earls, and to those of all the children, both sons and daughters, of viscounts and barons. It is also conferred on persons filling certain offices of trust and dignity, such as the maids of honour of the queen and queen dowager; and collectively on certain public bodies or institutions, as the House of Commons, the Congress of the United States, &c. &c. The title of *right honourable* is given to all peers and peeresses of the United Kingdom; to the eldest sons and all the daughters of peers above the rank of viscount; to all privy councillors; and to some civic functionaries, as the lord mayors of London and Dublin, the lord provosts of Edinburgh and Glasgow, &c.

Hood Moulding. The moulding which is introduced in Mediæval Architecture, to throw off the rain from the tracery, or to protect it

from dust, is called the hood moulding. It is generally made of the depth of the arch in which the tracery is introduced; but if the latter be continued below the level of the springing, the hood mould is also prolonged. The character of the mouldings differs slightly in Norman and Pointed architecture; being in the former merely a fillet accompanied by a splay, often ornamented with a billet and zigzag; and in the latter an ogee moulding with a hollow on the side of the tracery. In the English and the perpendicular styles, the hood mouldings are often terminated by brackets, shields, or heads.

Hooded Snake. The Cobra di Capello, or *Naja tripudians* of Cuvier, a poisonous snake frequently used by the Indian jugglers, after the poison-fangs have been removed.

Hookah. An Asiatic pipe, in which the smoke of the tobacco is made to pass through water in order to cool it.

Hooping Cough. A contagious spasmodic cough, of which the medical name is *pertussis*, from the Latin tussis, *a cough*. This disease lasts from three weeks to six months, according to the robustness of the patient, the time of year, or the mildness of the season. It generally attacks children, and commences with simple catarrh, which after ten days or a fortnight assumes the character of hooping cough. The peculiar sound produced by the patient, to which the disease owes its name, is caused by a long and violent inspiration following the numerous expiratory efforts made during the cough. The paroxysms are generally very violent, and terminate in the excretion of a glairy mucous discharge from the bronchial tubes, and vomiting occurs also in most cases. The disease is not accompanied with any febrile disturbance when uncomplicated, and its pathology is still unexplained, belonging as it probably does to the mysterious class of blood diseases. The treatment consists in the exhibition of mild sedatives, sudorifics, and aperients. Rhubarb and ipecacuan are highly extolled, and also prussic acid. Counter-irritation to the spine is practised with occasional advantage. Under all methods of treatment, however, a great point is gained by keeping the patient in a moderate temperature (from 64° to 66° Fahr.), and exhibiting light and nutritious food.

Hoopoe. In Ornithology, the vernacular name of the *Upupa Epops*.

Hop (Ger. hopfen, Fr. houblon). The *Humulus Lupulus* of Linnæus, the female flowers of which are used for imparting a bitter flavour to malt liquors for the purpose of preserving them from fermentation. The hop plant is a perennial indigenous to Britain and different parts of Europe; but to produce abundance of hops it requires to be very carefully cultivated in good soil, and even then is one of the most precarious of crops.

The fields in which hops are grown are commonly called hop gardens: a loamy soil on a dry subsoil is chosen, and the plants are placed in hills, stools, or groups of three or four, the hills being in rows five or six feet apart, and at about the same distance in the row. A full crop is not produced till the fourth or fifth year after planting. Every year the ground is dug in winter, and kept clear of weeds during summer; and the hills have poles, generally three or four to a hill, for the plants to twine on: the purchase of these poles, the fixing them in the soil every spring, the taking them down and stacking them every autumn, and their renewal every five, six, eight, or ten years, according to the kind of wood used, constitute a considerable part of the expense of hop culture.

The hops when mature are picked by hand, and as they are picked they are carried to a drying kiln [HOP OAST], dried, and packed into bags or pockets; and this is also an expensive process.

The hop plant is particularly liable to be injured by insects, by cold and continued rains, and by thunder storms; in consequence of which it is estimated that a full crop is not obtained oftener than about once in five years. Hence it is easy to conceive that the price of hops must vary greatly in different years, and that the grower who has a command of capital may profit largely by keeping them back from market when the prices are low, and selling them when they are high. In order to keep hops for two or three years, they require to be powerfully compressed, and put into much closer canvas bags than when they are to be sent immediately to market; they also require to be kept in dry airy lofts, neither too warm nor too cold. The culture of hops was introduced into England from Flanders in the reign of Henry VIII. The most extensive plantations are in Kent, Surrey, Sussex, and Herefordshire; but they are cultivated to a considerable extent in other counties. The hop growers are now no longer placed under the surveillance of the excise, the duty having been abolished.

Hop Oast. A particular sort of kiln used for drying hops. The floor of the kiln is generally of wire cloth, and the heat is generated in a stove with flues below. The hops after being put on the kiln are frequently turned, and in general they are rendered sufficiently dry in the course of a few hours; when dried they are taken to a loft and left to cool for a day or two, and then put into bags, having been previously subjected to the slight action of the fumes of burning sulphur (sulphurous acid), by which they are to a certain extent bleached.

Hop Poles. Poles or stakes annually inserted at the roots of hop plants for their stems to twine round. When a hop plantation is first made, as the plants are weak, the poles are not required to be more than five or six feet in length; but in the third or fourth year they require to be ten or twelve feet in length. Any kind of young trees or saplings may be used as hop poles; but the most durable are those of the oak, the ash, the sweet chestnut, and the larch. Much of the durability of the

hop pole no doubt depends on the soil in which it is grown; but, all circumstances being alike, poles of larch wood, which are much employed in the neighbourhood of Farnham, have been found to last longer than any other.

Hopeite. A mineral named after Dr. Hope, late Prof. of Chemistry at Edinburgh; it is said to be a hydrous phosphate of zinc and cadmium.

Hoplites (Gr. ὁπλῖται, from ὅπλα, *arms*). The heavy-armed infantry of Grecian antiquity. According to the Athenian regulations (similar probably to those of other states), the higher classes of citizens only, as estimated by the census, were liable to this expensive form of military service; in process of time, however, it seems that the Thetes or inferior classes also served as Hoplites. The Hoplites were armed in early times with the spear, heavy defensive armour, and large shield; the latter were exchanged after the time of Iphicrates for the light cuirass and target.

Horae (Lat.; Gr. Ὧραι). In Mythology, divinities regarded in two points of view—as the goddesses of the seasons, and of the hours of the day. Their duty was to hold the gates of heaven, which they opened to send forth the chariot of the sun in the morning, and receive it again in the evening. No classical poet has described them with greater beauty than Shelley, in his *Prometheus Unbound.* These goddesses are often depicted as forming the train of Aphroditê or Venus. (Homer, *Hymn. ad Ven.* 145; Hes. *Erg.* ver. 75, and *Hymn. ad Apoll.* 194; Gray's *Ode on the Spring.*)

Horary Circles. On globes, circles marking the hours, drawn through the poles at a distance of 15° from each other. They are the same as *meridians.*

Horary Motion. The apparent motion of a celestial body in an hour. The apparent horary motion of the heavenly bodies in their diurnal revolution is 15°; for as the whole circle is completed in 24 hours, the twenty-fourth part of it, or 15°, must be passed over in one hour.

Horde. A name given to the migratory bands of nomadic nations who, like the Tartars, unite plunder and rapine with a pastoral life.

Hordein (Lat. hordeum, *barley*). A modification of starch, which constitutes about fifty-five per cent. of barley-meal.

Hordeolum (Lat. dim. of hordeum). A small tumour on the eyelid, somewhat resembling a barley-corn; it is a little boil projecting from the edge of the eyelid, and is commonly called a *stye.*

Hordeum (Lat.). The genus of the Barleys and Barley-grasses, distinguished by having its spikelets in threes, arranged on opposite sides of the rachis, so as to form a distichous spike. [Barley.]

Horehound (derivation uncertain). The *Marrubium vulgare,* an indigenous plant with a bitter and somewhat aromatic flavour, and considered as an expectorant, and as giving relief in asthma; hence the celebrity of *horehound tea* and *candied horehound* among the common people.

Horizon (Gr. ὁ ὁρίζων κύκλος, *the boundary circle*). In Astronomy and Geography, the plane of a great circle of the sphere, dividing the visible from the invisible hemisphere. The horizon is either *sensible* or *rational.* The sensible horizon is a plane which is a tangent to the earth's surface at the place of the spectator, extended on all sides till it is bounded by the sky; the rational horizon is a plane parallel to the former, but passing through the centre of the earth. Both the sensible and rational horizon are relative terms, and change with every change of the spectator's position on the surface of the earth; in all cases they are perpendicular to the direction of gravity.

Horizon, Artificial. The plane of the horizon is a tangent to the curvature of the earth at any place, and is assumed very nearly by the surface of a quiescent liquid, which thus becomes an artificial horizon from which the altitude, of a heavenly body for instance, may be measured. From the law of the reflection of light, it follows that the angle subtended at the eye of an observer by a star and its image as seen reflected from such a liquid surface is twice that of the altitude of the star above the horizon. On account of its high reflecting power, mercury is the liquid generally used for an artificial horizon.

Horizontal Parallax. [Parallax.]

Horizontal Range. [Gunnery.]

Horn. Horny matter in general (such as cow-horn, tortoise-shell, quill, claws, nails, whalebone, &c.) is intermediate in composition between albumen and gelatine; it does not furnish gelatine when boiled in water, but by the proper application of heat it may to some extent be softened, so as to admit of moulding by pressure into various forms. Horn gradually dissolves in the caustic alkalies, and on neutralising the solution with an acid, a precipitate is obtained resembling that from similar solutions of the albuminoid compounds. The average ultimate composition of horn may be represented as 50 per cent. of carbon, 7 of hydrogen, 23 of oxygen, 17 of nitrogen, and 3 of sulphur. The earthy and saline matters of the more perfect varieties of horn do not exceed 2 or 3 per cent. [Cornua.]

Horn, French. A brass musical wind instrument of a complex spiral form, increasing in diameter to its end or mouth, which the French call its *pavillon.* The inflexion of it is much regulated by the insertion of the hand in the pavillon. Of late years the scale and intonation of the horn have been very much improved by the addition of valves, as in the Cornet-à-Pistons [which see].

Horn Silver. A name given by mineralogists and also by the older chemists to chloride of silver, which when fused puts on a horny appearance. For the same reason chloride of mercury or calomel is occasionally called *horn quicksilver,* and chloride of lead *horn lead.*

Horn-work. In Fortification, a work composed of two half-bastions and a curtain, with two long sides called *wings.*

——————— The *Carpinus Betulus* of botanists; a useful tree of the Corylaceous order. The wood is white, hard, and heavy (whence the name), but apt to be shaky, and therefore not well adapted for constructive purposes, though it forms excellent fuel. It is also a very useful hedge plant, being patient of the knife, and holding on its dead leaves during the early part of winter.

Hornbills. [BUCEROS.]

Hornblende. A mineral of a dark-green or black colour, abounding in oxide of iron, and entering into the composition of several of the trap rocks. It is the *amphibole* of Haüy.

Hornblende Rock. A rock of which hornblende is the principal ingredient. Hornblendic granites are called *syenite*, and consist of quartz and felspar, with hornblende instead of mica. Hornblendic porphyry is quartz and hornblende.

Hornblende Schist. A slaty variety of hornblende, generally including felspar and grains of quartz; it is of a dark-green or black colour. Where clay slate is in contact with granite, it sometimes passes into hornblende slate.

Horner's Method. A method of solving, numerically, algebraic equations of all degrees. It constitutes unquestionably the most important step made in this branch of mathematics since the time of Vieta. It was first published in the *Phil. Trans.* for 1819; its inventor, Mr. W. G. Horner, was at that time a teacher of mathematics at Bath; he died in 1837. We propose here to give a short sketch of the nature of the method, referring readers who may desire to become expert calculators by this method to the *Ladies' Diary* for 1838, to the article 'Involution and Evolution' in the *Penny Cyclo.*, or to Young's or Todhunter's *Theory of Algebraic Equations*, for further details.

The chief merit and peculiarity of Horner's method may be said to consist in a convenient and uniform process for finding the values of the successive derived functions of a given rational and integral function $F(x)$, corresponding to any given value a of x. This process will be sufficiently explained by the following diagram, which has reference to the quintic

$$F(x) = Ax^5 + Bx^4 + Cx^3 + Dx^2 + Ex + F,$$

and in which every new symbol immediately below a horizontal line represents the sum of the two quantities, in the same vertical column, immediately above that line; thus,

$$L = Ka + H, \quad \tfrac{1}{2}F''(a) = Oa + M, \text{ \&c.} \dots$$

$$\begin{array}{cccccc}
A & B & C & D & E & F \\
 & \underline{Aa} & \underline{Ga} & \underline{Ha} & \underline{Ia} & \underline{Ja} \\
 & G & H & I & J & F(a) \\
 & \underline{Aa} & \underline{Ka} & \underline{La} & \underline{Ma} & \\
 & K & L & M & F'(a) & \\
 & \underline{Aa} & \underline{Na} & \underline{Oa} & & \\
 & N & O & \frac{1}{\lfloor 2}F''(a) & & \\
 & \underline{Aa} & \underline{Pa} & & & \\
 & P & \frac{1}{\lfloor 3}F'''(a) & & & \\
 & \underline{Aa} & & & & \\
 & \frac{1}{\lfloor 4}F^{iv}(a). & & & &
\end{array}$$

Now, $F(x+a) = Ax^5 + \frac{1}{\lfloor 4}F^{iv}(a)x^4 + \frac{1}{\lfloor 3}F'''(a)x^3 + \frac{1}{\lfloor 2}F''(a)x^2 + F'(a)x + F(a)$,

so that by the above process we are enabled to form readily the equation $F(x+a) = 0$, whose roots are each less by a than the roots of $F(x) = 0$.

To illustrate the application of Horner's method, let us suppose that by STURM'S THEOREM, or in some other way, we have ascertained that $F(x) = 0$ has a root between 30 and 40 [THEORY OF EQUATIONS]; then the equation $F(x+30) = 0$, which we proceed at once to form, will have a root between 0 and 10. Newton's method of approximation [EQUATION], the last process having supplied the necessary data, will now lead us without much trouble to the determination of two consecutive numbers, say 2 and 3, between which a root of the last equation must lie; so that by repeating the last process we shall be able to form the equation $F(x+32) = 0$, whose roots are less by 2 than those of the last: in other words, less by 32 than those of the first, and which further has a root between 0 and 1. Newton's method will now lead to a new approximation, and the operation may be repeated. Proceeding in this manner, it is clear that from $F(x) = 0$ we may deduce an equation $F(x+a) = 0$ having a root as near to 0 as we please. This done, the corresponding approximate root of the original equation will, of course, be $x = a$. It is scarcely necessary to mention that Horner's method is immediately applicable to the extraction of the ordinary roots of numbers. To find the fifth root of 10, for example, it is merely necessary to solve the equation $x^5 - 10 = 0$; in other words, to make in the above scheme

$$A = 1, \; B = C = D = E = 0 \text{ and } F = -10.$$

Hornet. [VESPIDÆ.]

Horning, Letters of. In Scottish Law, a species of diligence (i.e. process) against a debtor. They are writs in the king's name, proceeding on the warrant of a decree of the court of session, or of the magistrates of boroughs, and of various other inferior authorities; but in these cases a warrant of the court of session must also be obtained. They direct the debt to be paid within a limited number of days (according to the nature of the debt). In default of such payment the debtor incurs the charge of rebellion, and is thereupon liable to *caption* or arrest.

Hornpipe. The name of a well-known dance, for the skilful performance of which the British sailors have long been celebrated. The origin of the name is uncertain; but it is believed to be derived from a kind of musical instrument called *pib-corn* (Ang. *hornpipe*), consisting of a wooden tube with holes and a reed, and a horn at each end, which was formerly used in Wales. (Barrington's *Archæologia*, vol. iii. 177.)

Hornstone. A variety of flint of a semi-transparency somewhat resembling that of horn. One of the varieties of porphyry goes under the name of hornstone porphyry.

Horography (Gr. ὥρα, *hour*, and γράφω, *I write*). The art of drawing hour-lines, or of constructing dials.

Horologium Florae (Lat.). A time-table of flowers, formed by noting the hours when they respectively open and close.

Horology (Gr. ὥρα, and λόγος, *discourse*). This word signifies literally an explanation of the methods of measuring and marking the hours of the day. Anciently the term *horologium* was applied to any sort of contrivance for measuring the hours, as the CLEPSYDRA and SUN-DIAL [which see]; but as these instruments have been succeeded by clocks and watches, horology is now usually understood to signify a description of the principles on which machines for the measurement of time, moved by weights or springs, are constructed.

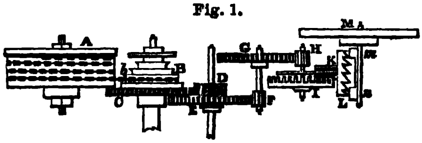
Machines for measuring time are designated by the general appellation of *clocks* and *watches*; but they are also distinguished by peculiar names arising from certain modifications in their construction, or from certain particular purposes which they are intended to serve. By the term *clock* is understood an instrument which not only shows, but also strikes, the hours. A *time-piece* is one which shows the hours without striking them; a *quarter-clock* is one which strikes the quarters as well as the hours; an *astronomical clock* is one which shows sidereal time; a *watch* is a portable or *pocket time-piece*; a *repeater* is one having a contrivance by means of which it can be made at any time to repeat the hours; a *chronometer* is a watch of the best kind, or one fit to be employed for astronomical purposes. A *marine chronometer* is a large kind of watch, specially constructed and hung for sea voyages.

In a general view, horological machines may be regarded as consisting of three essential parts: 1. A moving power, which produces a rotatory motion about an axle; 2. A train of wheel-work, by means of which a velocity is obtained having any required ratio to that of the primary axle; 3. A regulator, by which the rapidity of the revolution is determined, and uniformity of motion produced. The moving power is either a heavy weight which descends by the force of gravity, or a spring which is coiled up within a barrel and unwinds itself by the force of its elasticity: the first is preferred on account of the perfect regularity of its action when the instrument is to remain fixed in a place; the second is necessary for pocket time-pieces and those which cannot be kept in a fixed position, as on shipboard. The train of wheel-work is chiefly remarkable on account of the delicacy and accuracy of its construction. The regulator is either a pendulum, of which, by the theory of falling bodies, the oscillations are isochronal or performed in equal times; or a heavy balance, the reciprocal vibrations of which are also isochronal. [BALANCE; PENDULUM.]

Of the various mechanical contrivances introduced into horological machines for accomplishing particular purposes, it would be useless to attempt a description in this place, as our limits will not permit them to be given with that minuteness of detail which is indispensable in order to convey a clear idea of their action. The most important is the *escapement* (or scapement), or that part of the mechanism by which the original rotatory motion is converted into a reciprocating motion, and gives impetus to the pendulum or balance. Some other parts are also of primary importance; as the *maintaining power*, a contrivance by means of which the motion is maintained, or the machine kept going, while the weight or spring is being wound up; the *fusee*, by which in watches and spring-clocks the force acting on the wheel-work is rendered equal in all states of the tension of the spring. [FUSEE.]

The general arrangement of the wheel-work of a clock or watch may be understood from the following description. Fig. 1 represents

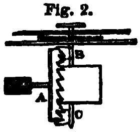
Fig. 1.



the movement of a common vertical watch, the frame plates being omitted, and the dial being supposed to be turned downwards. A is the *barrel* containing the spring which produces the motion. B is the *fusee*, connected with the barrel by the chain *b*. C is the *fusee-wheel*, called also the *first* or *great wheel*, which turns with the fusee, and works into the pinion D, called the *centre-wheel pinion*: this pinion, with the *centre wheel* or *second wheel* E, turns once in an hour. The centre wheel E works into the *third-wheel pinion* F; and on the same arbor is G, the *third wheel*, which drives the fourth or *centrate-wheel pinion* H, and along with it the *centrate wheel* I. The teeth of this wheel are placed at right angles to its plane, and act in the pinion K, called the *balance-wheel pinion*; L being the *balance-wheel*, or *scape-wheel*, or *crown-wheel*, attached to the same arbor. The balance-wheel acts on the two pallets *m* and *n* attached to the *verge* or arbor of the balance M; and these being placed at a distance from each other equal to the diameter of the balance-wheel, and in different planes, receive alternately from the scape-wheel an impetus in opposite directions which keeps up the vibratory motion of the balance.

This last part of the mechanism, which it requires some attention to understand, is represented more distinctly in fig. 2, where A is the scape-wheel, and B and C the two pallets. The pallets, it is to be observed, are not placed on the verge in the same plane, but their planes form an angle equal to the excursion of the balance; so that, supposing one of them to be about 40° or 50° from the mean point towards the right, the

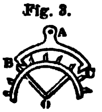
Fig. 2.



other is just as many degrees from the same point towards the left. The teeth of the scape-wheel are bent forward in the direction of the motion, like the teeth of a saw, and their number is odd. Suppose, now, a tooth of the scape-wheel to have caught the pallet B; it will continue to bear on that pallet, and to accelerate the balance, until, by the revolution of the verge, the extreme edge of the pallet comes into the plane of the extremities of the teeth, when the pallet escapes. But as the balance continues for a short time longer to move in the same direction, the pallet C now comes in between two teeth at the point diametrically opposite to the front of the tooth which B has just quitted; and as the vibration of the balance now commences in the opposite direction, this pallet is in its turn pressed upon and accelerated by the wheel.

The *Crown-wheel Escapement*, now described, is the oldest and the original form, and is still used in common watches, where it answers sufficiently well; but when applied to clocks regulated by pendulums, it is exceedingly defective; for, as it requires the vibration to be made in an arc of considerable extent, the pendulum must of necessity be short and light, and hence it becomes a very imperfect regulator. In order to obviate these defects, Clement, a London watchmaker, in 1680, invented the *crutch* or *anchor* escapement, which was greatly improved upon by Graham about the year 1700. Graham's escapement is represented in fig. 3.

Fig. 3.



O is the centre of the scape-wheel. B A C, the crutch or anchor, consists of a heavy piece of metal attached to the rod of the pendulum with which it moves. A is its centre of motion; and in the original construction of Graham, the distance of A from O was equal to the diameter of the scape-wheel. The extremities of the crutch form the pallets, the acting faces of which are inclined planes; while the parts on which the teeth successively fall are cylindrical surfaces, the radii of which are equal to O A. The tooth, being received on this surface, slides along it without tending to accelerate or retard the pendulum, until the pendulum arrives near the middle of its vibration, when the inclined plane comes to the extremity of the tooth, and the tooth then begins to act upon the plane, and to turn the pallets, and consequently accelerate the pendulum. By this arrangement the motion of the wheel continues only during the short time the tooth is sliding along the plane of the pallet, while during the rest of the vibration the tooth rests on the cylindrical surface, and the wheel stands still, or is *dead*; whence this escapement is called the *dead beat*, or the *escapement of repose*. In Hooke's form, where the cylindrical surfaces are wanting, the impulse given to one pallet carries the opposite with some force against the approaching tooth, and drives the wheel backward, or produces a recoil; and this force being applied at the extremities of the vibrations, tends greatly to disturb their isochronism. By Graham's method there is no recoil: the impetus is given while the pendulum is near the middle of the vibration, and the velocity the greatest; and during the rest of the vibration the pendulum is nearly altogether free of the action of the wheels.

Numerous other modifications of the crutch escapement have been proposed, and some of them carried successfully into effect; but for their description we must refer to the works in which the subject is technically treated. There are two, however, which, by reason of the greater ingenuity displayed in their contrivance, and their almost universal application to the best kinds of pocket watches, require particular notice. These are the *duplex* and the *detached* escapement, the latter being that which is used in modern chronometers.

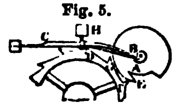
Duplex Escapement.—This is represented in fig. 4. A A is part of the scape-wheel, which is furnished with two sets of teeth, whence probably the name is derived. M N R are the teeth of repose, lying in the plane of the wheel; *mnr* are the teeth of impulse, and stand perpendicular to the plane of the wheel.

Fig. 4.

B C is the impulse pallet, fixed upon the arbor of the balance just above the plane of the wheel, so that its extremity C may be caught by the teeth *mnr*, and receive the impulse from them as they successively pass. A small ruby roller is also placed upon the arbor, behind the pallet, having a notch in one side of it for receiving the teeth M N R. When the tooth *m* has passed the claw of the pallet, the tooth M falls upon the ruby roller, where it rests until by the returning vibration of the balance the notch is brought to the point of the tooth. The tooth then falls into the notch, and thus passes the roller; and the next impulse tooth *n* comes up to the pallet, on the point of which it acts with great advantage in consequence of the long lever. As the successive impulses are all given in the same direction, the balance necessarily makes two vibrations for each impulse given by the upright tooth. The chief advantage of this construction consists in there being only one pallet, and in the action being independent of great accuracy in the execution of the teeth of the scape-wheel, which is indispensable in the case of the escapements already described, and also for the lever escapement, which in fact is only a modification of the crutch.

Detached Escapement.—The annexed diagram, fig. 5, represents Earnshaw's construction. A is the main pallet projecting from the verge or arbor of the balance, concentric with which is another small pallet, called the *lifting pallet*, which, when the balance is vibrating from A towards B, lifts a very slender spring B, and with it the detent spring C, so as to set at liberty or

Fig. 5.



unlock the tooth D, the point of which rests on a ruby pin projecting from the detent spring C, and forming the detent. The point E of the principal pallet having passed the tooth F, the wheel moves forward by the action of the mainspring, until the next tooth G falls upon the ruby pin and is locked. The screw H serves to adjust the position of the detent and the strength of the locking. In the return of the balance, the pallet A passes easily by the detent spring by forcing back the slender spring B. As in the case of the duplex, the balance here makes two vibrations for each impulse.

Maintaining Power.—In order that a clock or watch, when perfectly regulated, may continue to indicate true mean time, it is necessary that it should have some contrivance for continuing the action while it is wound up. Various methods of accomplishing this have been devised. One of the simplest consists in the interposition of a spring between the fusee and the wheel impelled by it, a little inferior in force to the mainspring (or weight), so as to remain always bent until the pressure of the mainspring is removed by the action of winding, when it begins to act upon a fixed point on one side and the wheel of the fusee on the other, so as to propel the work for a short time with a force nearly equal to that of the mainspring.

Some of the other parts of the mechanism, as the wheels for moving the minute and second hands, the striking part of a clock, and the repeating part of a watch, though they form a considerable part of the bulk of the machine, require no great refinement of invention or dexterity of construction, and will be better understood from the inspection of a common clock and repeating watch than from any description which could be given.

The history of the invention of clocks is very imperfectly known. By some it has been ascribed to Pacificus, archdeacon of Verona, in the ninth century, and by others to Boethius in the early part of the sixth. The Saracens are supposed to have had clocks which were moved by weights as early as the eleventh century; and as the term is applied by Dante to a machine which struck the hours, clocks must have been known in Italy about the end of the thirteenth or beginning of the fourteenth century. It is said that the first clock made in England was furnished out of the proceeds of a fine imposed upon the chief justice of the King's Bench in 1288, and that it remained in its original situation, in Old Palace Yard, as late as the reign of Elizabeth. In the reign of Richard II. a large astronomical clock was made by Richard of Wallingford, abbot of St. Alban's, which was regulated by a fly. But the most ancient clock of which we possess any certain account was erected in a tower of the palace of Charles V., king of France, about the year 1364, by Henry de Wick, or de Vick, a German artist. A clock was erected at Strasburg about 1370, at Courtray about the same period, and at Spire in 1395. In the following century public clocks appear to have existed in all the principal towns of Europe, and private ones to have come into very general use.

The earliest clocks were doubtless very rude and imperfect instruments, and their present state of excellence must have been attained by slow and successive improvements. Wheel work, set in motion by springs and weights, was known in the time of Archimedes; and in order to have a timepiece it was only necessary to apply some contrivance to regulate the motion. For this purpose recourse was first had to a fly-wheel; but it would soon be found that the fly, the action of which depends on the resistance of the air, would form a very imperfect regulator. The clock of Henry de Wyck, above mentioned, was regulated by an alternating balance, which was formed by suspending two heavy weights from a horizontal bar fixed at right angles to an upright arbor, and the movement was accelerated or retarded by diminishing or increasing the distance of the weights from the arbor. It had no regulating spring, and the action may consequently be supposed to have been very irregular; nevertheless, clocks regulated in this way were used for astronomical purposes by Walther, Tycho Brahe, Mœstlin, the landgrave of Hesse, and others. The capital improvement of the pendulum dates from about the middle of the seventeenth century; but it is very uncertain by whom the application was first made or proposed. Galileo was the first who remarked, or at least the first who formally announced, in his work on mechanics and motion, which was published in 1639, the isochronal property of oscillating bodies suspended by strings of the same length; and it has been pretended that he actually applied a pendulum to a clock for the purpose of observing eclipses and determining longitudes. There is, however, no absolute proof of this fact. Sanctorius, in his *Commentary on Avicenna*, describes an instrument to which he had applied a pendulum in 1612. Richard Harris is said to have constructed, in 1641, a pendulum clock in London for the church of St. Paul, Covent Garden. Vincenzo Galilei, a son of Galileo, is stated, on the authority of the *Academy del Cimento*, to have applied the pendulum in 1649. It was applied by Huygens in 1656; and by Hooke, for whom the invention has been claimed, about 1670. But to whomsoever the merit may belong of having first made the application, Huygens is unquestionably the first who accurately explained the theory of the pendulum; and hence, perhaps, the invention of the pendulum clock has been usually ascribed to him. Huygens demonstrated that the vibrations in circular arcs are not independent of the length of the arc, and that in order to obtain perfect isochronism, the ball of the pendulum must move in the arc of a cycloid; and, ingeniously applying a property of the cycloid, of which he was the discoverer, namely that its involute is a curve similar to itself, he procured the requisite motion by causing the pendulum to vibrate between cy-

cloidal cheeks about which the upper and flexible part of the suspending rod wrapped itself in its motion. But it was found that no practical advantage could be obtained from this beautiful contrivance; and, in fact, it was soon rendered unnecessary by the invention of the anchor escapement, which gives the means of rendering the arcs of vibration very small, in which case the error depending on the length of the arc becomes insensible. The application of the spiral spring to the balance is the undoubted invention of Hooke.

Another invention, which marks an epoch in the history of horology, is that of a method of counteracting the effect of changes of temperature on the pendulum rod and balance. The mercurial compensation pendulum was invented by Graham about the year 1715. Graham likewise suggested the method of effecting the compensation, by means of the unequal expansions of different metals, an idea which was subsequently realised by Harrison in the construction of the gridiron pendulum, which is now very generally used. The compensating apparatus in the watch balance depends upon the same principle, but the mechanical arrangement is necessarily very different. [Balance.]

For full information on this subject, the reader is referred to the following works: Denison, *Rudimentary Treatise on Clocks*; Berthoud, *Essai sur l'Horlogerie*; Id. *Histoire de la Mésure du Tems*; Cumming's *Elements of Clock and Watch Work*; Derham's *Artificial Clockmaker*; Harrison's *Principles of his Timekeeper*; Earnshaw's *Explanations of Timekeepers*; Reid's *Treatise on Clock and Watch Making*; the art. 'Horology' in the *English Cyclopædia*; Beckman's *Hist. of Inventions*, &c.

Horopter. The surface of single vision corresponding to any given binocular parallax is thus named.

Horoscope (Gr. ὡροσκόπος, from ὥρα, *an hour*, and σκοπέω, *I observe*). A representation of the aspect of the heavens and positions of the celestial bodies at a particular moment, drawn according to the rules of the imaginary science of astrology. Thus the aspect of the heavens at the moment of the birth of an individual is his *horoscope*, and supposed to indicate his future destinies. [Astrology.]

Horse. [Equus.]

Horse. In Nautical affairs, a foot-rope to support the feet of the seamen while leaning over a yard or boom to furl the sail. Also, a rod or rope along which the edge or the corner of a sail traverses by means of hanks.

Horse Artillery. [Artillery.]

Horse Fly. [Hippobosca.]

Horse-chestnut. *Æsculus Hippocastanum.* The seeds of this tree contain a considerable quantity of starch, accompanied by a peculiar bitter principle, tannin, and mucilage. Attempts have been made to separate the starch for domestic purposes, but hitherto without much success. According to Flandin (*Comptes Rendus* xxvii. 391), when the peeled and bruised chestnuts are well kneaded in a very dilute solution of carbonate of soda, the starch separates, and after having been well washed becomes nearly tasteless. A bitter substance called *argyroscin* has been extracted from the horse-chestnut by Rochleder. [Æsculine.]

Horse-power. The unit adopted in estimating the power of steam engines. It is of the dynamic value of 33,000 lb. raised one foot high per minute. In buying engines a certain area of piston was supposed to represent a horse-power, and in Watt's early engines the dynamic and commercial units were nearly equivalent. This is, however, no longer the case, and in some modern engines the dynamical or indicated horse-power is as much as nine times greater than the nominal or commercial power. [Steam Engine.]

Horseradish. The root of the *Cochlearia Armoracia*, which when scraped is often eaten as a condiment and an ingredient in sauces. It has a place in the *Materia Medica* as a stimulant, and a compound spirit and compound infusion are directed in the *Pharmacopœia*: the latter very soon becomes putrid, and neither are useful. The root of *aconite* has occasionally been accidentally substituted for that of the horseradish, and has proved fatal.

Horticulture (Lat. hortus, *a garden*, and colo, *I cultivate*). The culture of the kitchen garden and orchard. In the kitchen garden are cultivated all kinds of root, herb, flower, and fruit, used in cookery; and in the orchard the more hardy fruits used in cookery, and in the dessert. The finer fruits are grown against espaliers, walls, hot walls, or under glass. The chief difference between horticulture and agriculture is, that in the former the culture is performed by manual labour in a comparatively limited space called a garden; while in the latter it is performed jointly by human and animal labour in fields, or in an extensive tract of ground called a farm. [Gardening; Agriculture; Farming.]

Hortus Siccus (Lat. *a dry garden*). A collection of dried plants preserved in books or papers.

Horus or **Hor-apollo.** In Egyptian Mythology. [Harpocrates.]

Hosanna (Heb.). An exclamation, signifying literally *save now*. This Hebrew word occurs only once in the Old Testament, viz. Psalm cxviii. 25. This psalm is the last of those which compose the *great Hallel*. It was commonly adopted in the Christian church.

Hospital (Fr. hôpital, from Lat. hospitium, *a place for lodging strangers*). A building for the reception of persons incapable of taking care of themselves, or of procuring medical assistance. Many of the charitable institutions of Great Britain are called *hospitals*, as Christ's Hospital, London, Heriot's Hospital, Edinburgh. The English medical hospitals are incorporated bodies possessed of great wealth, which is expended in the support of medical schools.

Hospital Gangrene. A species of ulcerating gangrene, peculiarly characterised by

its infectious nature, and its tendency to attack wounds or ulcers in crowded and ill-ventilated hospitals.

Hospitaller (Fr.; Lat. hospitium). In its original acceptation, this name was applied to certain religious bodies, who held it their duty to provide lodging and entertainment for persons engaged in pilgrimages. One of the most celebrated institutions of this kind was that at Jerusalem, which gave its name and origin to the Knights Hospitallers—instituted about the end of the eleventh or the beginning of the twelfth century. They soon afterwards settled in England, and gradually attained a degree of wealth and importance unequalled in the history of similar bodies. They followed the rule of St. Austin, and wore a black habit with a white cross upon it. At their original institution they were styled Knights of St. John of Jerusalem; afterwards Knights of Rhodes, and again Knights of Malta; these two islands having been successively conferred on them by different monarchs. [St. John of Jerusalem, Knights of.]

Hospitium (Lat.). This word signifies in general a place or inn for the reception of strangers, in which sense it is used by old writers; but it is in modern times almost wholly restricted to the celebrated inns on St. Bernard and St. Gotthard, in Switzerland, to which travellers to and from Italy resort.

Hospodar (Slavonic). The lieutenants appointed by the Porte to govern the two Christian principalities of Moldavia and Wallachia are so called in the Levant. By the treaty of Adrianople between Prussia and Turkey (1829), these officers were to hold their appointments for life, and pay a fixed annual tribute. Under the treaty of Paris, 1856, and by the subsequent arrangement of 1861, acceded to by the Porte, the principalities have been formed into one province, named Roumania, under a single prince.

Host (from the Latin hostia, *a victim*). In Theological language, the bread and wine under the appearance of which the Roman Catholics conceive the body and blood of Christ to be present upon the altar. The elevation of the Host is a ceremony prevalent in all Catholic countries, in which the consecrated elements are raised aloft and carried in procession through a church, or even through the streets of a city. On these occasions the people fall on their knees and worship the Host. The origin of the custom is dated from the twelfth century, when, it is said, it was thought necessary to make this public and conspicuous declaration of the Eucharist on the occasion of the promulgation of the opinions of Berengarius against transubstantiation.

Hostage (perhaps from Lat. obses, obsidis, through the Low Latin form obstagius). A person left as surety for the performance of the articles of a treaty. The practice of taking hostages is now almost unknown in the mutual relations of civilised communities; but was formerly so common as to have given rise to many questions in the law of nations. Hostages were divided into principal and accessory; the latter being where it is expressly stipulated by treaty that the hostage shall be answerable for the event. One of the points debated among civilians on this subject was, whether such a hostage could lawfully stake his life, and whether in the event of his doing so it was lawful to take it. The affirmative was argued from the most ancient example of hostageship on record, Reuben's words to Jacob, 'Slay my two sons if I bring not Benjamin back.' According to Philip de Comines, the Liegois having given hostages to Charles duke of Burgundy, with express power to put them to death in the event of an infraction of the treaty, and that event having taken place, it was much debated in the council whether the power should not be carried into execution; but after much discussion their lives were spared. It has also been questioned whether a hostage can be delivered up against his will: Grotius decides in the affirmative. The extent of the rights of conquerors over hostages, the events which may dissolve their obligation, the effect of their escape upon the convention between the principals, and other points of the subject, are treated at length by writers on national law.

Hot Blast. The stream of heated air forced through a furnace is known by the name of the hot blast, when the temperature of the air is made about 300, 400, or even 600 Fahr. The effect of this, in the iron furnace, is the production of a greater quantity of metal from the ore; but the texture of the metal is impaired.

Hot Shot. Common shot heated in a furnace, and fired against shipping and combustible material. When shot are heated, it is necessary to reduce the charge of powder.

Hot Well. The reservoir for the water pumped out of the condenser of a steam engine by the air-pump.

Hotchpot. In Law, a blending or mixing together of lands given in marriage with lands in fee falling by descent. As if A had two daughters, and gives a third part of his lands in marriage with one of them to her husband, and dies seised of the other two thirds: in order to acquire any further share of these lands, the married daughter must bring the lands first given into hotchpot; that is, she must renounce the gift, and allow the land to be confounded with the rest, in order that she may inherit her whole share; otherwise her sister will have the remaining two thirds of the lands. There is also a rule of hotchpot with respect to the distribution of personal property within the stat. 22 & 23 Ch. II. c. 10; as, where a certain sum is to be raised and paid to a daughter for her portion by a marriage settlement, if the daughter would have any further share of her father's personal estate she must bring this money into hotchpot, and allow it to form part of the distributable residue.

Hotel (Fr.; Old Eng. hostel, from Lat. hospitium). This word signifies, in a general sense, a large inn for the reception of strangers; but in France it is applied especially to the residences

of the king, nobility, or other persons of rank: or it is used synonymously with hospital, as the *Hôtel Dieu*, *Hôtel des Invalides*, &c.

Hothouse. A general term for the glass structures used in Gardening, and including stoves, greenhouses, orangeries, and conservatories. Pits and frames are garden structures with glass roofs, with the sides and ends of masonry or wood, but they are generally so low as not to admit of being entered, and this seems to prevent them from being included under the term *hothouse*. [Stove; Greenhouse; Pits and Frames.]

Hotpressing. In Printing, a mode of giving a glossy appearance to books. The printed sheets are placed between glazed or milled boards to a thickness together of about five inches, and laid on two cold iron plates at the bottom of a hydraulic or screw press, then a cold plate, a hot plate, another cold plate, a further supply of sheets between glazed boards, and so on till the press is full. The press is then pumped up, or screwed down with a powerful lever, and left for a short time.

Hottentots. The inhabitants of the southern extremity of Africa. They exhibit many and manifest points of dissimilarity with the pure negroes, with the Caffres, and with the other indigenous African races. They are usually of small size, of a dusky olive complexion; high cheek-bones, and crisp woolly hair. Some of them, as the Griquas, are much mixed with European blood from the Dutch Boers. The Hottentots are on the whole docile, and some have been disciplined as soldiers for the purpose of defence against the other aboriginal tribes.

Hotwall. In Gardening, walls for the growth of fruit-trees, which are built with flues or other contrivances for being heated in severe weather, so as to facilitate the ripening of the wood or the maturation of the fruit. The most common form of hotwalls is that in which flues or tunnels are conducted through them, into which the smoke and heated air from fires are made to ascend from a furnace at the bottom of the wall to a chimney on the top; but in some cases hotwalls are formed by constructing the entire wall hollow, tying the two sides together by cross-stones or bricks, and introducing heat by means of pipes of metal containing steam or hot water along the bottom of the vacuity, the heat of which rises to the top of the wall, and heats every part in its progress. In all climates north of the meridian of London, hotwalls are of great use for ripening fruits and young shoots, and preserving tender plants. [Wall.]

Hound (Ger. hund, Gr. κύων). It is not easy to determine from what original stock English hounds have sprung. [Canis.] The several varieties in this country have during the last century been diminishing in number, and are now reduced practically to three—the foxhound, the harrier, and the beagle. The staghound, now nearly extinct, is a mongrel bloodhound; the latter to produce this variety being crossed seemingly with some lighter animal, as a greyhound or a lurcher. The foxhound is also sprung from a graft on the old English bloodhound, apparently within the last 150 years. The harrier, now being different from the harriers of half a century back, may be considered as a miniature foxhound. The beagle, an animal with great beauty of form, is now nearly extinct; as a hunting dog, it is comparatively useless, being noisy, and apt to dwell on the scent, while the game is escaping. The greyhound is no longer classified among dogs used in chase, since he has been deprived of the necessary faculty of smell. (Stonehenge, *The Greyhound in* 1864.) The terrier, probably so called from his eagerness to get under ground, no longer accompanies foxhounds, as foxes are not so often digged for as formerly. (*Encyclopædia Britannica*, s.v. 'Hound.')

Hounds. In Maritime language, the projecting parts of the sides of the mast, near its head, which, like shoulders, support the rigging.

Hour (Lat. hora, Gr. ὥρα). In its general acceptation, denotes the twenty-fourth part of a mean solar day, or of the time in which the earth makes a complete revolution in respect of the sun. The division of the artificial day, or time from sunrise to sunset, into twelve equal parts, belongs to the remotest ages of antiquity (Goguet, *Origine des Loix, &c.*); the division of the *night* into the same number of parts was introduced at Rome in the time of the Punic wars. The Italians make the day commence at sunset, and reckon on to twenty-four hours, or to the succeeding sunset. Astronomers reckon twenty-four hours from midday to midday; but in the civil reckoning only twelve hours are counted, namely from midnight to midday, and from midday to midnight. The hours which result from the division of the artificial day into twelve parts are called *temporary hours*, from being of unequal lengths at the different seasons of the year.

Hour Angle of a Heavenly Body. The angle at the pole between the celestial meridian and the circle of declination passing through the place of the body.

Hour Circles. [Horary Circles.]

Hours. In Mythology. [Horæ.]

Hours, Canonical. The seven hours of prayer, observed, it is said, by the Catholic church since the fifth century; chiefly in monasteries. The number seems before that time to have varied, although some peculiar seasons of the day and night were always set apart for this observance. They became finally fixed at seven by the rule of St. Benedict; a number, perhaps, recommended by a literal acceptation of the words of David (Psalm cxix.), 'Seven times a day will I praise Thee.' These hours are termed, in the language of the Latin church, *matins*, *prime*, *terce*, *nones*, *vespers*, *compline* or *completorium*, which last takes place at midnight. At the time of the Reformation the canonical hours were reduced in the Lutheran church to two, morning and evening; the 'reformed' church never observed them. (Bing-

ham's *Ant. Eccl.* 5; Ersch and Gruber's *Encycl.* 'Horæ.')

Hour-glass. A species of chronometer or clepsydra, measuring intervals of time by the running of water or sand from one glass into another.

Houris. The name given by Europeans to the imaginary beings whose company in the Mohammedan paradise is to form the principal felicity of the *believers.* The name is derived from hûr al oyûn, signifying *black-eyed.* They are represented in the Koran as most beautiful virgins, not created of clay, like mortal women, but of pure musk; and endowed with immortal youth, and immunity from all disease. (*Koran,* chap. lv. lvi. Sale's translation; and the Prel. Discourse, s. 4.)

House (Ger. haus). A human habitation above the ground. Amongst eastern and southern nations, houses are usually found to be flat at the top, with the ascent to the upper storey by steps on the outside. As we proceed towards the north, a declivity of the roof becomes necessary to throw off the rain and snow, which are of greater continuance than in lower latitudes. Among the ancient Greeks and Romans, the houses usually enclosed a quadrangular area or court open to the sky. This part of the house was by the Romans called the *impluvium,* or the *cavædium,* and was provided with channels to carry off the water into the sewers. (Smith's *Dictionary of Greek and Roman Antiquities,* s.v. 'Domus.') The word *house* is used in various ways; as in the phrase *a religious house,* by which either the buildings of a monastery or the community of persons inhabiting them may be designated. In the middle ages, when a family retired to the lodge connected with the mansion, or to their country seat, it was called *keeping their secret house.* (*Northumberland Household Book.* See also *Domestic Architecture in England:* Oxford, Parker.)

House of Commons. [PARLIAMENT.]

House of Correction. A prison for the punishment of idle and disorderly persons, vagrants, trespassers, &c.; regulated by 4 Geo. IV. c. 64 and other statutes. [BRIDEWELL; PRISON.]

House of Lords. [PARLIAMENT.]

Household Brigade. The household troops, consisting of the two regiments of life guards, the royal horse guards, and the three regiments of foot guards, are so called. These troops perform the special duties of honour about the person of the king or queen.

Household Coal. The coals best suited for domestic use are those which burn in a steady and uniform manner, leaving a black cinder and little ash, and giving out the greatest quantity of heat. The district affording this kind of Coal in the north of England extends from the Tyne to the Wear, and from the last river to Castle Eden, and occupies another area about Bishop Auckland.

The best household fire-coal was for many years produced from the High Main Coal of the Tyne, the immediate colliery being called Wallsend, and hence the origin of the designation Wallsend to distinguish the best household fire-coal. It is also obtained from the various collieries of Percy Main, Walker, Heaton, Willington, &c., on the Tyne, and from the Hutton seam on the Wear.

Household, The Queen's. The chief officers of the queen's household are: 1. The lord steward; in whose office are the treasurer and comptroller of the household, &c. 2. The lord chamberlain, under whom are the vice-chamberlain, lords in waiting, grooms in waiting, gentlemen of the privy chamber, yeomen of the guard, gentlemen pensioners, &c. 3. The master of the horse. The mistress of the robes is at the head of the ladies of the queen's household, and has under her regulation the duties belonging to the bedchamber, and the rotation of service of the several ladies, viz. eight ladies of the bedchamber, eight bedchamber women, eight maids of honour.

Household Troops. [GUARDS.]

Householder. In Law, the occupier of a house. Where the right of voting for members of parliament is in inhabitant householders, it has been settled by a current of decisions that no one is to be considered as such who does not possess the exclusive right to the use of the outward door of the building. He retains the character, however, although by taking inmates he may for a time have relinquished the exercise of that exclusive right. The *outward door,* to satisfy this description, need not be a door opening on the public way; a room or set of rooms having a separate and exclusive outward door (as chambers in one of the Inns of Court) may in the eye of law constitute a house. The same principle is followed in criminal law, where to constitute the offence of burglary, it is necessary that a *house* shall have been broken and entered.

Houseleek (A.-Sax. leac, *a leek or plant*). The *Sempervivum tectorum* of botanists, a plant forming rosulate tufts of succulent leaves, from which arise stout flower-stems bearing pink polypetalous star-shaped flowers. It is commonly met with in this country on cottage roofs and old walls, and is esteemed by country people for its cooling properties.

Housing. In Architecture, the space taken out of one solid, to admit of the insertion of another, is called *a housing.*

Hovel. An open shed for sheltering cattle, for protecting produce or material of various kinds from the weather, or in which are performed various agricultural operations during heavy rains, falls of snow, or severe frosts. In common language, the term is generally applied to the meanest kind of cottages.

Hoven. The inflation of the stomach and intestines of cattle in consequence of the imperfect digestion and fermentation of their food. [TYMPANITIS.]

Howitzer (Ger. haubitze, Fr. obusier). A piece of ordnance used for throwing shells. Howitzers are shorter, and have much less

weight of metal, than guns of the same calibre. [ORDNANCE.]

Hoy (Dutch, huy). A small vessel having generally one mast, and ordinarily used for the carriage of luggage to and from larger vessels and the shore.

Hubert, Order of Saint. The highest Bavarian order of knighthood, founded in 1444.

Hucho. A species of trout (*Salmo Hucho*) found in the Save, Laybach, and other rivers tributary to the Danube: it attains a weight of about three pounds. 'The skin of this fish is thick; the scales smaller than those of the common trout, and the pectoral fin has four spines more, which I think enables it to turn with more rapidity. Fried or roasted, he is a good fish; his flesh is white, but not devoid of curd, and though rather softer than that of a trout, I have never observed in it that *muddiness* or peculiar flavour which sometimes occurs in trout even in perfect season.' (Davy's *Salmonia.*)

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Hurdle (Dutch horde, Ger. hürde). A frame made of wood or iron, for the purpose of forming temporary fences. The frame consists of two perpendicular stakes, into which are fixed five or six horizontal bars, and the whole is braced together by one or two diagonal pieces. When a fence is to be formed, the hurdles are put down end to end; they are made fast to the ground by the insertion of the lower end of the stakes into it, and to one another by a tie fastened round their upper ends, or by a movable wooden pin passed through them.

Huronia. A name given to certain radiated articulated bodies formerly referred to the *Polyparia*, found in the transition limestone of Lake Huron. (*Geol. Trans.* vol. i. new series.)

Huronite. A mineral from the vicinity of Lake Huron; it occurs embedded in black Hornblende, and is a hydrated silicate of alumina, lime, magnesia, and protoxide of iron.

Hurricane (Span. huracan, an American word). A violent storm, generally accompanied by thunder and lightning, and distinguished from every other kind of tempest by the vehemence of the wind, and the sudden changes to which it is subject. Hurricanes prevail chiefly in the East and West Indies, the Isle of France, and in some parts of China. [Storm; Tornado.]

Hurst (A.-Sax.). A wood; hence the termination of the names of several places in England, particularly in Kent and Sussex.

Hurter (Fr. heurtoir). In Artillery, a piece of timber placed along the head of a gun platform, at the foot of the interior slope of the parapet, to prevent the latter from being injured by the wheels of the gun-carriage.

Husbandry. A comparatively primitive term, including both agriculture and gardening, or all those country occupations which the father of a family was expected to perform in the country. The term is now commonly used as synonymous with *agriculture*. The *Berwickshire husbandry*, the *convertible husbandry*, are terms used in agriculture for certain systems of cropping in which the land is alternately kept under grass and tillage.

Hussars. A kind of light cavalry, used in all the armies of Europe. The term is of Hungarian origin (being derived from husz, *twenty*, and ar, *pay*, every *twenty* houses furnishing *one* man), and was first applied to the body of troops raised by the nobles of Hungary on occasion of the appeal made to the latter in 1458 by Mathias Corvin. Their arms consist of a sabre, a carbine, and a pair of pistols. In the British cavalry there are thirteen regiments of hussars. [Cavalry.]

Hussites. The followers of John Huss, a Bohemian reformer and divine, who was convicted of heresy by the council of Constance, and burnt by order of the emperor of Germany, in 1415. The writings of Huss and Jerome of Prague were the source from which Luther drew a great part of his opinions and views; but it was from the books of Wiclif that Huss was himself induced to institute his enquiries into the faith and morals of the church. The errors charged against him contain many of the opinions now held by all Protestants; but several of these he himself denied, and those for which he ultimately suffered have not been universally held by reformers, nor do they seem of very great importance. They were these: 1. That Pope Sylvester and the emperor Constantine did evil to the church when they enriched it. 2. That if any ecclesiastic be in a state of mortal sin, he is disqualified for the administration of the sacraments. 3. That tithes are not dues, but merely eleemosynary. On the other hand, he held the Romish idea of transubstantiation; and the opinion of the necessity of communion in both kinds, which became afterwards the most remarkable feature in the doctrines of the Hussites, is not in reality to be ascribed to their founder. The condemnation of Huss is also remarkable, as it is from the circumstances attendant on it that the imputation of not keeping faith with heretics is originally charged upon the Roman church. The emperor Sigismund gave Huss a safe-conduct, to secure him from any ill consequences that he might apprehend from delivering himself up voluntarily to be examined by the council. Nor did the council assert any right to condemn him. They handed him over to the secular arm, to the emperor himself. But it is confidently asserted that when the emperor scrupled to violate a promise which was undoubtedly binding upon him, it was at the pressing instance of the pope or cardinals that he allowed the execution to take place. Their apologists affirm that this safe-conduct imported only that Huss might *go to Constance* without being harmed; the words of the original instrument, however, are reported to be, *Transire, stare, morari, redire libere permittatis.* (Milman, *History of Latin Christianity*, book xiii.)

After the execution of Huss, and of his disciple Jerome in the following year, there arose a violent insurrection among their partisans in Bohemia, who maintained themselves for many years by force of arms, and split into two sects, under the denominations of the Calixtines and the Thaborites. The former, so called from demanding the cup in the sacrament, were finally reconciled to the church by the concession which they required. The latter were so called from the name they gave to the hill on which they pitched their camp in the neighbourhood of Prague, and carried their notions upon the authority of the church and its ministers, ceremonies, and all the externals of religion, to the length of an extreme simplicity. The Bohemian Brothers and the Beghards, who gave so great an impulse to the Reformation, were the descendants of this branch of the Hussites. (Cochlæus, *Hist. Hussitarum*; Gieseler's *Text-book*, iii. 355, translation.)

Hustings (probably from A.-Sax. hus, *house*, and ting, *court* or *judgment*). The principal court of the city of London, held before the lord mayor and aldermen: also, in common language, the booth or elevated place on which

candidates at a parliamentary election are proposed, and address their constituents.

Hutchinsonians. The name given to those who embraced the opinions of John Hutchinson, a philosopher and naturalist of the eighteenth century. The chief characteristics of Hutchinson's philosophy consist in his rejection of Newton's doctrine of gravitation; and in his maintaining the existence of a plenum on the authority of the Old Testament, which according to him embraces a complete system of natural philosophy as well as of religion. (See his works, 12 vols. 8vo. 1748.)

Hyacinth (Gr. Ὑάκινθος). In Botany, the name of a popular spring flower, *Hyacinthus orientalis*, of which numerous garden varieties, chiefly with blue, red, or white blossoms, are cultivated. To the same genus belongs the common Harebell, *Hyacinthus non scriptus.*

HYACINTH. In Mineralogy, the term Hyacinth or Jacinth is applied to the transparent bright varieties of Zircon, which differ from Jargoon merely in their red colour.

Hyacinthine. [MEIONITE.]

Hyacinthus (Gr. Ὑάκινθος). In Mythology, the son of Amyclas king of Laconia, accidentally killed by Apollo, who immortalised his favourite by causing the flower which still bears his name to spring from his blood, and inscribing the word **AI** on its leaves, to indicate the deep grief of the god for his loss. An annual festival, named Hyacinthia, was celebrated at Amyclæ in honour of Hyacinthus. (*Athen. Deipn.* iv. p. 139.)

Hyades (Gr. Ὑάδες, from ὕειν, *to rain*). In Mythology, the daughters of Atlas and Æthra, who, overwhelmed with grief at the death of their brother Hyas, wept so violently that the gods took them into heaven, where they still continue to weep, and are thence supposed to presage rain. They form a cluster of five stars in the face of Taurus.

Hyæna (Gr. Ὕαινα). A genus of digitigrade Carnivorous Mammals, separated by Storr from the *Canis* of Linnæus, from which it not only differs in dentition and other important particulars, but, in general, manifests a closer affinity with the *Viverridæ*; between which and *Felis* the genus *Hyæna* is placed by Cuvier. The characters of this genus are: five molars above and four below, on each side, the three anterior molars being conical, smooth, and remarkably large, adapted for breaking the bones of their prey; the tongue has a broad patch of cuticular spines on the anterior part of its dorsum; the legs are each terminated by four claws; there is a peculiarly large perineal glandular pouch; and the neck and jaws are remarkable for the strength of their muscles. The species of hyæna are nocturnal; they prey on dead carcasses. An extinct species (*Hyæna spelæa*) was abundant in England and France anterior to the glacial epoch, and has left its remains in many caverns in both countries.

Hyænanche (Gr. ὕαινα, *hyæna*, and ἄγχω, *I strangle*). A Euphorbiaceous plant, used at the Cape of Good Hope for poisoning hyænas, and hence called the Hyæna-poison. The species is *H. capensis.* It is used by sprinkling the powder of its fruit on raw flesh, which is left in the places which the animals frequent.

Hyænodon (Gr. ὕαινα, and ὀδούς, *tooth*). A genus of *Carnivora*, about the size of a leopard, which has left its remains in the upper eocene strata of Hordwell in Hampshire. It presents the typical diphyodont dentition of forty-four teeth. [DIPHYODONT.]

Hyalæa (Gr. ὕαλος, *glass*). A genus of beautiful Pteropodous Molluscs, remarkable for the delicacy and transparency of the shell. This bears a close resemblance to a bivalve, with the two valves unequal and soldered together at the hinge. That portion of the shell which corresponds to the ventral aspect of the animal is convex; the dorsal plate is nearly flat, and is longer than the other; the hinder or closed margin of the shell is produced into three sharp points. The inhabitant is provided with two large wing-like processes of the mantle, which it protrudes, when swimming, from the anterior open fissure of the shell. The species are found floating in the Mediterranean and tropical seas.

Hyalite (Gr. ὕαλος; λίθος, *a stone*). A yellow or grey variety of uncleavable Quartz or Opal; it is commonly concretionary or chalcedonic, of a vitreous fracture and lustre. It occurs in trap-rocks in grains, filaments, and botryoidal masses resembling colourless glass: it is silica combined with about 6 per cent. of water.

Hyaloid (Gr. ὕαλος, and εἶδος, *form*). A term applied to transparent membranes, and more particularly to that which invests the vitreous humour of the eye.

Hyalosiderite (Gr. ὕαλος, and σίδηρος, *iron*). A mineral consisting essentially of the silicates of magnesia and iron, from Sasbach, in the Brisgau. It is of a glassy lustre, and is a variety of Chrysolite.

Hybernaculum (Lat.). A term applied by Linnæus to denote a leaf-bud; which he rightly considered the winter-quarters of the point of growth in a plant.

Hybernation (Lat. hibernus, *wintry*). The act by, or the state in, which certain animals exist during that season of the year when excess of cold or of heat, or lack of food, prevents their going abroad and performing their customary functions. As this state is generally superinduced by the rigours of winter, it has received its denomination from that circumstance; but in the tropics the effects of the hottest and driest weather, in reducing the numbers of the insect world, are such as to render it necessary for many reptiles and some insectivorous mammals, as the *Tenrecs*, to pass into a state of inactivity or torpidity, in order to maintain life until the recommencement of the rainy season. The condition of hybernation is, in fact, less the alteration of temperature, than the abstraction of the means of subsistence dependent thereon; as, e.g., the disappearance of insects in the winter season of our own climate.

Animals so highly organised as the warm-

and quick-breathin [illegible] alia [illegible] ed organic machinery in action without frequent supplies of food; an interruption in this respect of a few days, or at most a few weeks, is fatal. If, therefore, the phenomenon of hybernation had been known only in the cold-blooded classes, an insectivorous mammal in a climate where insects could not subsist for several months in the year would be inconceivable. The modification of the vital powers by which a warm-blooded animal is made even temporarily to assume the state and properties of a reptile, is perhaps one of the most striking instances of special adaptations to meet an exceptional case that the history of animals presents. When the atmosphere becomes vacant of insect life, when the bat, in its nocturnal flittings, would vainly traverse it in search of food, and when the few insects that survive the winter have burrowed too deeply in the earth, or concealed themselves in hiding-places too secure for the reach of the hedgehog—these species, with starvation staring them in the face, are preserved by the suspension of those functions the maintaining of which in a state of activity is essentially dependent on an uninterrupted supply of nutriment. The bat suspends itself in the innermost recesses of its cave, the hedgehog creeps to its concealed nest, and both resign themselves to deep repose; but the breathing becomes gradually slower than in ordinary sleep, the pulsations of the heart diminish in force and frequency, the supply of stimulating arterial blood to the muscles and the brain is progressively reduced, relaxation of the muscular fibres is converted into stiff inaction, and sleep sinks into stupor: at length respiration entirely ceases, and with it those chemical changes in the capillary circulation on which animal heat mainly depends. The preservation of life, in its passive or latent state, is now due to the irritable property of the heart's fibre, which is excited to contract by the present dark or carbonised state of the blood, and continues to propel it slowly over the torpid frame during the whole period of hybernation. This slow circulation of venous blood through both the pulmonic and systemic vessels is the only recognisable vital act during that period, and the material conveyed by the absorbents into the circulating fluid is sufficient to counterbalance the slight waste thus occasioned. So long, therefore, as the state of torpidity continues, the hedgehog and bat are independent of supplies from without, but they purchase that independence by a temporary abrogation of their vital faculties.

The hybernation of lizards, snakes, frogs, toads, and other cold-blooded reptiles, is accompanied by analogous changes, differing only in degree; for as the heart in these animals is, at all times, destined to propel blood imperfectly oxygenated—as the respiratory or oxygenating apparatus is imperfect—and as the heat of the body in them rises and falls with the external temperature, a slight deterioration of these lower conditions of the circulating and respiratory functions induces torpidity, with the consequent loss of appetite and independence of food. Some quadrupeds, as the dormouse and squirrel, which subsist on articles of diet better adapted to be laid up in store than insects, carry a winter provision to their hybernating nests; and their torpidity is more nearly allied to a profound but ordinary sleep; respiration is never wholly suspended; the waste of the organism is proportionate to the degree of activity in the working of the machine, and they occasionally rouse themselves and take in the requisite supply from their provident store. Insectivorous birds, being independent, through their power of traversing space, of the vicissitudes of climate and their consequences, transport themselves, when their food fails in one country, to latitudes favourable to its abundance: hence the immigration of the cuckoo and swallow at the commencement of the genial season, and their subsequent disappearance.

Hybodonts (Gr. ὑβός, *gibbous*, and ὀδούς, *tooth*). A family of Plagiostomous fishes found in all the secondary rocks from the trias to the chalk inclusive. The teeth of the hybodonts are conical, but broader and less sharp than those of true sharks. The enamel is strongly marked by longitudinal grooves and folds. One cone is larger than the rest, and called the *principal*; the others are *secondary*.

Hybrid (Lat. hybrida). The produce of a female plant or animal which has been impregnated by a male, of a different variety, species, or genus.

The most common hybrids are those which result from the connection of different varieties of the same species, as the produce of the wild boar and domestic sow; the endless modifications which result from analogous interbreeding from varieties of the rose and other ornamental or useful plants are familiar examples of the principle among vegetables.

Specifical hybrids have been produced by Kœlreuter from the artificial fertilisation of the *Nicotiana rustica* with the pollen of the *Nicotiana paniculata*; and it has been ascertained by numerous observations, that a multitude of plants produce specifical hybrids in a state of nature. Naudin has lately been occupied in hybridising gourds, and his researches are published in the *Annales des Sciences Naturelles*.

Hybrids from different species of insects, under similar circumstances, have been obtained; as from the connection of *Papilio Jurtina* with *P. Janira*, of *Chrysomela ænea* with *Chr. alni*, of *Phalangium cornutum* with *Ph. Opilio*. Specifical hybrids have been obtained in the class of fishes by artificial impregnation between the *Cyprinus Carpio* and *Cypr. Carassias*, and between the *Cypr. Carpio* and *Cypr. Gibelio*. In birds, hybrids have been bred between the goldfinch and canary, between the reeves and the common pheasant—the pheasant and the common fowl—the swan (*Anas Olor*, Linn.) and the goose (*Anas Anser*, Linn.)—between the *Tetrao*

Tetrix and *Tetrao Urogallus*—between the *Corvus Corone* and *Corvus Cornix*, &c. Among Mammals, hybrids have been produced between the lion and tiger, the dog and wolf, the dog and jackal, the dog and fox, the goat and ibex, the horse and zebra, the zebra and ass, and the horse and ass; the produce of the two last species, as it is the most common and useful of hybrids, being termed *par excellence* the mule.

But a fruitful connection is not only possible between individuals of different varieties or of distinct species, but also occasionally between animals of different genera. Generical hybrids have thus resulted from the union of the goat (*Capra Hircus*) with the antelope (*Antilope Rupicapra*), of the stag with the cow, and of the bull with the sheep, notwithstanding their disparity of size. Among reptiles, between the toad (*Bufo*) and the frog (*Rana*); among insects, between *Cantharis melanura* and *Elater niger*, and between *Melolontha agricola* and *Cetonia hirta*. Experiment alone can determine the amount of affinity beyond which fertilisation is impracticable, but at present it seems to be restricted to individuals belonging to genera of the same natural group.

The tendency of all the natural phenomena relating to hybridity is to prevent its taking place, and when it has occurred to arrest the propagation of varieties so produced, and to limit their generative powers so as to admit only of reversion to the original specific forms.

It would seem that in most cases the fertilising particles had a specific power over the ova derived from the same species, or were attracted by them in a peculiar manner; for the milt and roe of different species of fishes are not unfrequently excluded in the same locality, yet hybrids are not met with in consequence. Spallanzani was not able to impregnate the ova of the frog with the semen of the newt, nor to produce a fertile combination of those of the toad and newt; nor did the injection of the semen of the dog into the vagina of the cat impregnate any of her ova.

The individuals of different species which produce a hybrid offspring do not voluntarily copulate. The salacious mare must be blindfolded, or she will not receive the ass. The stallion refuses to mount the she-ass, if a mare be in sight. Hunter states that, when he desired 'to have a she-wolf lined by some dog, she would not allow any dog to come near her, but was held while a greyhound dog lined her; while in conjunction she remained pretty quiet, but when at liberty endeavoured to fly at the dog.' Buffon reared puppies of the wolf, fox, and dog together, to familiarise them with each other; but when they were in heat, the females of each species exhibited an insurmountable repugnance to the male of the others, and mortal combats ensued instead of fertile union between the different sexes of the different species. (*Annales du Muséum*, t. xii. p. 119.)

In a few exceptional cases, serving only to establish the rule of their infertility, specifical hybrids have been known to propagate together, and produce a degenerate intermediate race, which soon becomes extinct; it more commonly happens that a hybrid is sterile, or propagates only with an individual of pure breed.

On the assumption that a hybrid produced by two individuals of undoubtedly distinct species is sterile, experiments have been made on the breeding powers of hybrids, to determine the nature of doubtful species. Thus Hunter believed that he had obtained absolute proof of the jackal being a dog, and to have equally made out the wolf to be of the same species; and he then proceeds to speculate whether the wolf is from the jackal, or the jackal from the wolf; for he had obtained pups from the connection of a female hybrid jackal-dog and a male terrier, and between a female hybrid dog-wolf and a male greyhound; and he adds, in respect of the latter fact, that 'it would have equally proved the same fact if she had been lined either by a wolf, a dog, or one of the males of her own litter.' (Hunter's *Animal Economy*, by Owen, 8vo. p. 323.) But this assertion, that the fertility of a hybrid with an individual of a pure breed proves the fact of the identity of two supposed distinct species equally with the production of offspring from the connection of hybrid with hybrid, cannot be admitted. To prove the identity of two supposed distinct species, on the assumption that the fertility of the hybrids from the two gives the proof required, it should be shown that such hybrids are fertile among themselves, and capable of propagating indefinitely an intermediate variety. Hunter's celebrated experiments, however, only proved that two nearly allied species will produce a hybrid offspring, and that such hybrid may be impregnated by an individual of the pure breed; but this fact illustrates the general law by which the reversion of the hybrid to the pure breed is provided for; while, on the other hand, the intermixture of distinct species is guarded against by the aversion of two specifically different individuals to sexual union.

Hydarthrus (Gr. ὕδωρ, and ἄρθρον, *a joint*). The *white swelling*. The joints most subject to it are the knee, elbow, wrist, and ankle. It is distinguished from rheumatic swelling of the joints by a fixed and wearing pain preceding the tumefaction, and often existing for a long time before any enlargement of the part is perceptible: also by the general state of the habit.

Hydatids (Gr. ὑδατίς, *a bladder*). A term somewhat vaguely applied both to morbid cysts and true Entozoons of the order *Cystica*. Of the latter some are globular, with a tunic composed of a double albuminous membrane between which the sporules or ova are developed. In the species developed in the human liver, the ova are detached from the internal surface, and it is hence termed *Acephalo-cystis endogena*. In a species infesting similar organs in the lower animals the ova are detached from the external surface, and it is called *Acephalo-cystis exogena*. In a higher organised genus

of Hydatids, a slender and more or less elongated process is continued from the cyst, and terminates in an extremity provided with suckers and a coronet of recurved hooklets, like the head of a tapeworm: this genus is termed *Cysticercus*. Another genus has numerous similarly organised appendages attached to the cyst, and is accordingly termed *Cœnurus*. A hydatid of the last genus is developed in the brain of sheep, and produces the *giddy sickness* or *staggers*. [ACEPHALOCYST.]

Hyde or **Hide.** A measure of land common in Domesday Book and old English charters. The derivation of the name is fancifully traced to the ancient fable (common to many nations) of the deceit practised by a colonist in acquiring from the owners so much land as he could cover with the hide of an ox, and then dividing it into strips so as to make it extend over a large space. Its contents are also uncertain, but are stated by some authorities to amount to 100 Norman or 120 English acres. (Warner's *Hist. of Hampshire*; Ellis's *Introduction to Domesday.*)

Hydnocarpus (Gr. ὕδνον, *a tuber*, and καρπός, *fruit*). Of this genus of *Pangiaceæ*, one species, *H. venenata*, produces a fruit of the size of an apple, covered with a brown velvety down. This fruit is of a very poisonous character, and is used by the Cinghalese to poison fish, which is thereby rendered unfit for food. The seeds contain a considerable quantity of oil, which is used medicinally.

Hydra (Lat.; Gr. ὕδρα). In Astronomy, one of the ancient constellations in the southern hemisphere.

HYDRA. In Mythology, a monster, which was said to infest the lake Lerna in Peloponnesus. According to the fable, when one of its heads was cut off, it was immediately succeeded by another, unless the wound was cauterised. Heracles is said to have destroyed this monster by the constant application of firebrands to the wounds as the heads were cut off. The term *hydra* is sometimes used in a metaphorical sense for any manifold evil.

HYDRA. In Zoology, this name is restricted to a genus of minute fresh-water Polyps. The term *Hydrus* was applied by Linnæus to a genus of water-snakes.

Hydracids. Acids containing hydrogen as one of their essential elements; such as the hydrochloric acid, the hydriodic acid, &c.

Hydragogue (Gr. ὑδραγωγός, *conducting water*). This term is generally applied to violent cathartics, which bring away a large quantity of watery secretion from the intestines.

Hydrangeaceæ (Hydrangea, one of the genera, from Gr. ὕδωρ, and ἄγγος, *a vessel*). An order of perigynous Exogens of the Saxifragal alliance, the chief marks of which are the opposite exstipulate leaves, and the distinct styles. Lindley places it between *Saxifragaceæ* and *Cunoniaceæ*. Some of its species are ornamental, but of little utility. *Hydrangea Hortensia* and *H. japonica* are well-known decorative garden plants.

Hydrargo-chlorides. Compounds of the bichloride of mercury with other chlorides, forming a class of haloid salts.

Hydrargyllite (Gr. ὕδωρ, Lat. argilla, *clay*). A name given to the native phosphate of alumina, under the erroneous idea that it consisted of alumina and water.

Hydrargyrum (Gr. ὕδωρ, and ἄργυρος, *silver*). Quicksilver or mercury.

Hydrates. Compounds containing water as one of their proximate elements, and in definite proportion. Caustic potash is a *hydrate of potassa*, composed of 1 equivalent of potassa $=48$, and 1 of water $=9$. Slaked lime, which is an apparently dry white powder, is a *hydrate of lime.*

Hydraulic Danaide. In Hydrodynamics, a machine put in motion by the power obtained from a fall of water applied in a particular manner. A cylindrical trough of tin-plate is fixed to a vertical axis of iron, which passes through the middle of a hole in the bottom of the cylinder, the diameter of the hole being somewhat greater than that of the axis, so as to allow the water to escape. A drum of tin-plate, close above and below, is also fixed upon the axis, and placed within the trough; its diameter being so much less than that of the trough that a clear cylindrical space of about an inch and a half in thickness is left between the outer circumference of the drum and the inner circumference of the trough; and the bottom of the drum is also about an inch and a half from the bottom of the trough. This space between the two bottoms is divided into compartments, by diaphragms radiating from the axis to the circumference of the drum. Into the space between the two cylinders water is made to fall from a reservoir above, through one or more pipes, the ends of which are bent into a horizontal direction, so that the water escapes in the direction of a tangent to a horizontal section of the cylinders, and impinging on the interior surface of the trough, communicates a circular motion to the machine. The water between the cylinders thus acquires a centrifugal force, in consequence of which it presses against the interior surface of the trough and the diaphragms on the bottom; while, on the other hand, the action of gravity constantly tends to make it run out at the hole in the bottom. The moving power is measured by the weight of water escaping from the supply pipes multiplied into the height of the reservoir, and the useful effect by the same product diminished by half the force which the water retains when it issues from the hole in the bottom of the cylinder.

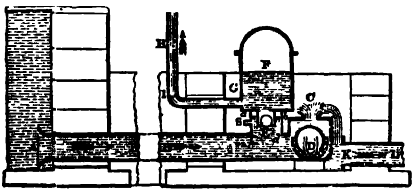
Hydraulic Mortar. Mortar which possesses the property of hardening under water is called *hydraulic mortar*. This property was ascertained by Vicat to be owing to the presence of clay in the limestone of which the mortar was made; or, in fact, to the presence of silicate of alumina in it. Vicat divided limestones into the pure limes, the moderately hydraulic, the hydraulic, and the energetically hydraulic.

The first were those which were, comparatively speaking, pure; the second had variable proportions of silicate of alumina present in the ratio of from 5 to 12 per cent.; the third showed the presence of from 12 to 20 per cent. of the silicate; the fourth from 20 to 30 per cent.; and the last was composed of variable proportions of the silicate of alumina, varying from 30 to 60 per cent., to carbonate of lime from 70 to 40 per cent.

With Portland cement, which is made of 16 parts of clay to 84 parts of limestone principally from the chalk formation, the rate of setting is influenced by the degree of heat to which the mixture has been exposed. The over-burnt portions will, for instance, be slow in setting, but attain great hardness under water; the properly burnt parts will set more rapidly, but will not be ultimately so hard as the over-burnt; while the under-burnt parts will set rapidly, but will not attain the same amount of hardness under water. The same thing occurs with every kind of hydraulic lime to a greater or less extent. [BÉTON; CEMENT.]

Hydraulic Ram or **Water Ram.** An ingenious hydraulic machine for raising water by means of its own impulse. The principle of its action and the mechanism o its construction may be described as follows:—

The water arriving at A from the reservoir with the velocity due to the height of the fall passes along the pipe A B, which should have an inclination of at least an inch for every two yards, escapes through an orifice C, which may be shut at pleasure by means of a valve. A reservoir F filled with air is attached by means of a cylinder, *a b c d*, to the pipe A B D; in the middle of the bottom of the reservoir F is a circular orifice, to which there is adapted a short cylindrical tube, of which the extremity



E is also furnished with a valve. Another valve S serves to supply the air to the space comprised between the cylinder *a b c d* and the tube E. G I H is an ascensional tube rising from the reservoir F. The water which escapes at C is carried off by the waste pipe K L.

The form of this apparatus (or perhaps its mode of action) suggested the name it has received. The pipe A B C is called the *body of the ram*; and the extremity, where the valves and the reservoir F are placed, is called its *head*. Both valves D and E are formed of hollow balls supported on muzzles, and of such a thickness of metal that they weigh about twice as much as the quantity of water which they displace.

We may now consider the effects of the engine when in action. The water flowing through the orifice C acquires the velocity due to the height of the fall, and raises the ball D from its support till it comes to the orifice C; the extremity of this orifice is covered with leather, or with cloth filled with pitch, so that when the ball is applied to it the passage of the water is effectually prevented. As soon as this orifice is closed, the water raises the ball E which had shut the orifice of the reservoir F; and a portion of it introduces itself into this reservoir, and into the pipe G I H. It thus loses the velocity which it had when the orifice C was shut, and the balls D and E fall down in consequence, the one on its support, and the other on the orifice at E. When this takes place, everything is in the same state in which it was at first. The water begins again to flow through the orifice C; the valve D is again shut; and the same effects are repeated in an interval of time which, for the same ram, undergoes little variation.

As often as the impulse is renewed, a quantity of water is forced up into the reservoir F and the tube H; and as it is prevented from returning by the action of the valve, it must necessarily be delivered at the extremity of H. The use of the air-vessel F is to keep up a continuous motion of the ascending column of water. The communication with the external atmosphere being cut off, the air within F is compressed by a force proportional to the height of the surface of the water in H above its surface in F; and this compressed air acting by its elasticity on the water maintains a continuous flow through H. The air-vessel, however, though it assists the action of the ram, is not an essential part of it; the continuity of the discharge of water may be effected by means of two or more rams, of which the ascensional pipes G I H all terminate in a single branch. On this principle works have been erected at Marly, in France, which raise water in a continuous jet to the height of 57 mètres, or 187 English feet.

As the ascending column of water communicates with the air in the reservoir F, this would soon be exhausted if a fresh portion of air were not introduced at each stroke of the ram. The little tube S, which is stopped by a valve opening inwards, serves for this purpose. At the instant when the orifice C is closed a recoil takes place, by which the water is thrown back from the head of the ram towards the cistern; and a partial vacuum being thus produced within the cylinder *a b c d*, the pressure of the external atmosphere forces open the valve in the canal S, and a portion of air enters the cylinder, whence it is driven into the reservoir, excepting the small part of it which lodges in the space between the cylinder *a b c d* and the tube E. (Hachette, *Traité des Machines.*)

The invention of the hydraulic ram, at least in the improved form here described, belongs to Montgolfier of Montpelier. A machine, however, on the same principle had previously

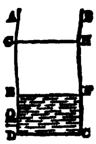
been suggested, and even erected at Chester, by our countryman, Mr. Whitehurst, but much less perfect in its mode of action; for the orifice C, instead of being opened and shut by the action of the water itself, required to be opened and shut by the hand by means of a stop-cock. Owing to this circumstance, Whitehurst's machine was of little utility, and appears to have soon been entirely forgotten.

Hydraulics. That branch of Natural Philosophy which treats of the motions of liquids, the laws by which they are regulated, and the effects which they produce. By some authors, the term *hydrodynamics* is usually applied to the general science of the motion of fluids; while *hydraulics* is more particularly applied to the art of conducting, raising, and confining water, and to the construction of water works. This latter signification appears to be the most consistent with the derivation of the words, though it is hard to draw the line between the two branches of the subject in practice.

There is no part of mechanical science which offers greater difficulties to the mathematician, or where the results of theoretical observation present so little agreement with experience. This arises from the excessively complicated nature of the movements which take place amongst the particles of a liquid mass when its equilibrium has been disturbed, and also partly from the great number of the disturbing causes by which those movements are effected.

The first and principal problem of hydraulics is to determine the velocity with which a liquid flows through an aperture in the bottom, or sides, of a containing vessel. In order to discover the law of this velocity, let *ABCD* (fig. 1) be a vessel filled with water to the height EF, and let O be a very small opening in the side of the vessel; while the water stands at EF, it will issue from O with a certain velocity depending upon the height of E F above O. Let it, therefore, be proposed to determine to what height G H the vessel must be filled in order that the velocity of efflux through O may be doubled. From the principles of hydrostatics it is shown that the force urging a particle of the fluid at O, through the orifice, is the pressure due to the height of the vertical column above O. Now we may consider, in the first place, that when the velocity of a particle in motion is doubled, the momentum, or moving force, must also be doubled; and, in the second place, if the velocity of efflux is doubled, the number of particles that will be put in motion in the same space of time will also be doubled; and consequently the momentum or moving force also must be doubled on this account. Hence, when the velocity of the discharge through O is doubled, the moving force, which in the present case is the pressure, must be quadrupled. But the pressure is proportional to the height of the fluid above O, hence the height must be quadrupled. By the same process of reasoning, we conclude that to obtain a threefold velocity, a ninefold depth would be necessary, and so on; and generally that the depths must increase as rapidly as the squares of the velocities; or, in other words, the velocities are proportional to the square roots of the depths of the orifice below the surface of the liquid in the vessel.

Fig. 1.



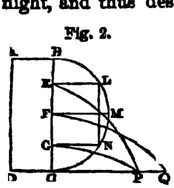
By means of this law, the absolute velocity with which water issues from an orifice at any depth under the surface may be ascertained, provided we can determine the velocity for any particular depth. Now, if we suppose the orifice O to be on a level with the surface of the liquid, or if we suppose O to be in the bottom of the vessel covered with an extremely thin film, there would be no pressure on a particle at O, which, therefore, would drop out merely by the effect of its own weight, and consequently with the velocity of a heavy body beginning to fall. But the velocity of a falling body is proportional to the square root of the height from which it has fallen; therefore, since it has been shown that the velocity of discharge through an orifice is proportional also to the square root of the height of the liquid above the orifice, and that the two velocities are the same in one particular case, it follows that they must be the same in all cases; and hence we have this important theorem, 'That the velocity with which a liquid issues from an extremely small orifice in the bottom or side of a vessel that is kept full, is equal to that which a heavy body would acquire by falling from the level of the surface to the level of the orifice.'

Several consequences follow immediately from this fundamental theorem. In the first place, if the aperture be enlarged, each particle of the liquid presenting itself there will escape with the same celerity; and hence the quantity of water that issues through an orifice is as the area of the section multiplied by the square root of the depth. Again, if the water be thrown up in a perpendicular jet, it ought to ascend to the height of the reservoir; or if several orifices be made in the same vessel, each presented upwards, the jets escaping from each of them would all rise to the same height. But by reason of the resistance of the air, the friction on the sides of the orifice, the mutual cohesion of the liquid particles which impedes their separation and escape, and the action of the opposing currents formed in the interior of the liquid, these conclusions must be received with considerable modifications. The effects of the disturbing causes can only be determined by a comparison with experiment.

Water issuing through a hole, or pipe, in the side of a vessel kept full, like other projectiles when the resistance of the air is supposed to be withdrawn, describes a parabola in a vertical plane. Let *ABCD* (*fig. 2*) be a cylindrical vessel filled with water, and E an orifice in its side; the water will be projected from E with a velocity that would carry it horizontally through double the space B E in the same time in which a body falls from B to E. But from the instant it escapes at E it begins to

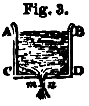
descend with an accelerated motion to the level of D C, while it continues its uniform horizontal flight, and thus describes a parabola meeting the ground in P. Now by the theory of projectiles the velocity of a body moving in a parabola is equal to that which is acquired by a body falling through half the parameter of the diameter, and it has been shown that the velocity at E is equal to 2 B E; therefore the directrix passes through B, and consequently $4\,BE \times EC = CP^2$. On B C, as a diameter, let there be described a semicircle B L C: then $BE \times EC = EL^2$, and consequently $CP^2 = 4\,EL^2$, whence $CP = 2\,EL$. The horizontal range is, therefore, the greatest when the aperture is at F in the middle of B C, and is then equal to C Q, which in its turn is equal to 2 F M, or to the altitude B C. In all other cases there are two apertures E and G equidistant from F which give the same range, for by the nature of the circle there are two equal ordinates, E L and G N.

Fig. 2.



There is a circumstance connected with the efflux of a liquid through an orifice which requires particular attention. While the liquid is flowing out in this manner, the particles continue to descend in vertical lines till they reach within a short distance of the orifice, as at C D (fig. 3), when those not immediately above it change the direction of their motion, and approach the orifice with very different obliquities, converging as it were to a centre, the position of which is somewhat without the orifice. In consequence of this tendency, the vein of water as it issues out is contracted, its breadth at *m*, *n* being less than the width of the orifice. The contraction of jet was first observed by Sir Isaac Newton, who gave it the name of the *vena contracta*, or the contracted vein of the liquid. The distance from the orifice at which the contraction is the greatest depends, in some degree, on the dimensions of the orifice itself; and it is equal to about half the diameter when the orifice is circular and small. The consequence of this contraction is that the discharge of water from a containing vessel is not so great as would be given by theory; but is reduced by the proportion of the breadth of the vein where the contraction is greatest, to that of the orifice. According to Newton this proportion is as 5 to 7 nearly, and according to Bossut as 5 to 8; but these figures would require to be altered according to circumstances that might occur in practice.

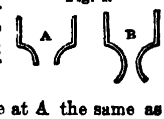
Fig. 3.



As the same quantity of liquid must evidently pass through the orifice and the contracted vein in the same interval of time, it follows that the velocity at the latter point must be greater; and by applying the theorem respecting the velocity of discharge, it is the velocity of the contracted vein that must be regarded.

It is found that if a short tube, about one or two inches long, is inserted in the vessel, and the water be allowed to flow through this tube, the contraction of the vein may be considerably diminished, and the quantity of water discharged through the tube is much greater in the same time than through an orifice of equal diameter. Ventura found that the discharge through a smooth hole in the bottom of a reservoir of tin amounted to 64 quarts in 100 seconds; a short pipe of the same diameter of the hole being applied to the bottom of the reservoir, so as to be flat and even with it, the discharge was augmented to 82 quarts in the same time; and on giving the bottom of the vessel the form here represented, leaving the orifice at A the same as before, the discharge was increased to 92 quarts. By enlarging the lower end of the pipe and giving it a curvature, as B, the quantity of water delivered in the same time received a still further augmentation: such additional pipes are called *adjutages*.

Fig. 4.



The velocity and other circumstances relative to the motion of water in conduit pipes, and in open canals and rivers, cannot be accurately determined from any abstract theoretical principles; but very numerous experiments have been made on the subject, from which results have been deduced of great value in directing the practice of the engineer. When water flows from a reservoir in horizontal pipes of the same diameter, the discharges made in equal times are nearly in the inverse ratio of the square roots of the lengths. But this rule applies within limits that are not very extended, and is not admissible with respect to long pipes; and, according to M. Darcy, it requires to be modified according to the nature and the state of the pipe. It was found by Bossut that water has its velocity diminished eight times in passing through a tube of one inch in diameter and 204 feet long. In order to obtain the greatest discharge from a pipe, it is necessary that the inside should be smooth, the width uniform, and sudden changes of direction be avoided. The want of evenness of surface impedes the motion of the fluid, which is further obstructed by any sudden changes in the direction, or the rate of flow. Whether the pipe or channel be contracted or enlarged, the change is always attended with a proportionate loss of velocity. Any sharp flexure of the pipe or conduit will occasion a still greater waste of the moving force. It has been found that a curvilinear pipe discharged less water than a rectilinear one of the same length; and that when the flexures are vertical the quantity is less than when they are horizontal. When a large pipe has a number of contrary flexures, the air sometimes mixes with the water and occupies the highest parts of those flexures, [illegible] means the velocity of the fluid is greatly retarded, and the quantity discharged greatly diminished. The ancient Romans appear to have

been aware of this fact, as they provided escapes for the air that might be brought down in their aqueduct bridges of Lyons and elsewhere.

When liquids flow through very small orifices, or capillary tubes, the resistance is greatly augmented, and the rules that apply to orifices or pipes of considerable diameter no longer hold good. In this case the velocity depends very considerably on the temperature of the fluid. Thus pure water at a temperature near the boiling point, is found to flow through a capillary tube five times faster than when the temperature is near the freezing point. Alcohol is found to flow six times faster than before, when the temperature is raised to 124°. Quicksilver is less affected, but it is found to endure heat through a wider range.

With respect to water running in open channels or in rivers, the resisting forces are so numerous, and of so irregular a nature, that it is difficult to attempt to deduce their effects from any general principles. In all cases the velocity is increased by the depth of the stream, and of the declivity over which it runs up to a certain limit, i.e. till the resistance, which increases with the velocity, becomes equal to the acceleration, when the motion of the stream becomes uniform. The resistance, of course, depends a great deal upon the evenness of the bottom and sides of the channel, which has lately been ascertained by the researches of Bazin to be a very important element in the calculations of the yield of such a mode of conveying water. The greatest velocity of a river is at the surface and in the middle of the stream, from which it diminishes towards the sides and bottom, where it is the least. It has been found by experiment that if from the square root of the velocity at the surface in the middle of the stream, expressed in inches per second, unity be subtracted, the square of the remainder will be the velocity per second of the water at the bottom. Thus let v = the velocity at the surface in the middle of the stream, then the bottom velocity will be expressed by

$$\overline{1)}^2 = v - \sqrt{2v+1}.$$

It has also been found, by experiment, that the mean velocity (or that with which, were the whole stream to move, the discharge would be the same as the real discharge) is equal to half the sum of the greater and less velocities, as computed by the above formula. The mean velocity is therefore

$$\frac{v + \overline{(\sqrt{v}-1)}^2}{2}.$$

These formulæ are deduced from the experiments of Du Buat. (Playfair's *Elements of Natural Philosophy.*)

When the sections of a river vary, the quantity of water remaining the same, the mean velocities are inversely as the areas of the sections; but when the river receives a permanent addition, the velocity is immediately increased. The effect of this is to augment the action on the sides and bottom, in consequence of which the width is augmented, and sometimes, though more rarely, the depth. This increase of width, by multiplying the points of resistance, again reduces the velocity till an equilibrium is established between the velocity and resistance; after which the bed of the river becomes as nearly permanent as the conditions of the flow of water will allow it to be. [River.]

The determination of the force with which a liquid in motion strikes a solid at rest, and the force necessary to propel a solid immersed in a liquid, is another important branch of the science of Hydraulics, though the name will hardly apply to it. Of the general principles hitherto deduced from theory, there are, however, only a few which afford a tolerable approximation to the results of experiment. The force of a stream must be regarded as compounded of the force of each particle, and of the number of particles that strike the object in a given time. Now, the force of each particle is proportional to the velocity with which it impinges; and the number of particles that strike in a given time is also proportional to the velocity of the stream, supposing its section to remain the same; hence the whole force of the stream is as the square of the velocity. It follows that if the plane struck by the stream be itself in motion, the impulse will be as the square of the differences of their velocities; and if a stream strike obliquely upon a plane, its force is less than if it struck directly in the same plane in the ratio of the cube of the sine of obliquity to the cube of the radius. But it would appear from experiment that this last consequence only holds true when the angle of inclination is greater than 60°. It might seem (and it is agreeable to theory to suppose) that a plane moving against a liquid at rest with a certain velocity, would receive the same impulse as if the liquid were to move with that velocity, and the plane to remain at rest. This, however, is not confirmed by experience, which proves that the resistance of a liquid to a body in motion is considerably less than the percussion of the liquid moving with the same velocity against the body at rest. The difference arises from the action of the liquid on the hinder part of the moving body, by which the resistance is in some degree counteracted; but the resistance depends very materially on the figure of the body, and the relation of its length to its breadth. A conical-shaped body, when its length is considerable, is more easily drawn through the water with its broad than with its narrow end forwards. In general it is found that whatever tends to diminish the adhesion of the body to the liquid, tends also to diminish the resistance. A wedge, which has its sides rubbed with grease, is found to move more freely through the water than if it were presented in its natural state; hence the great advantage of coating a ship's bottom with copper. [Resistance.]

The following are some of the best works on the subject: Belidor, *Architecture Hy-*

draulique; Frisi, *Opera Omnia*; Bossut, *Traité d'Hydrodynamique*; Du Buat, *Principes d'Hydraulique*; Prouy, *Nouvelle Architecture Hydraulique*; *Recherches Physico-Mathématiques sur la Théorie des Eaux Courantes*; Navier, *Résumé des Leçons donnés à l'École Polytechnique*; *Raccolta dei Autori Italiani che hanno trattato sur l'Acque Corrente*; D'Aubrisson's *Traité d'Hydraulique*; Eytelwein, *Handbuch der Mechanik*; Leslie; Young; Robison; Lardner's *Treatises on Hydraulics*; Nicholson's translation of Venturi's *Tracts*; &c. &c. A more complete list of the bibliography on this subject will be found in the tract upon Hydraulic Engineering in Weale's Series, by G. R. Burnell.

Hydrides. Compounds of hydrogen with other elements or radicals.

Hydriodic Acid. A gaseous compound of hydrogen and iodine, obtained by the mutual decomposition of iodide of phosphorus and water. It is composed of 126 iodine + 1 hydrogen; and its equivalent, therefore, is 127. The specific gravity of this gas is 4 4. It is rapidly absorbed by water, furnishing a sour dense liquid, which becomes brown by exposure to air, in consequence of the evolution of a little iodine. It is decomposed by chlorine, which abstracts the hydrogen to form hydrochloric acid, and sets the iodine free.

Hydrobromic Acid. A gaseous acid composed of 78 bromine + 1 hydrogen. It is obtained by the mutual decomposition of bromide of phosphorus and water.

Hydrocarbons. Compounds of carbon and hydrogen. These combinations are numerous, and form a variety of important gaseous, liquid, and solid products, the composition and characters of which are stated under other heads. Marsh gas and olefiant gas may be cited as instances of *gaseous*, oil of turpentine and benzole of *liquid*, and naphthaline and paraffin of *solid* hydrocarbons.

Hydrocardia. Dropsy of the pericardium.

Hydrocele (Gr. ὕδωρ, and κήλη, *a tumour*). A collection of watery or serous fluid in the tunica vaginalis testis.

Hydrocephalus (Gr. ὕδωρ, and κεφαλή, *the head*). Dropsy of the brain, or water in the head. The acute form of this disease is almost confined to childhood; it is marked by febrile symptoms, pain of the head, and in very young children enlargement of it. The eyes are irregularly directed and the pupil dilated. The eyes are not perfectly closed in sleep, and there appears a degree of delirium, as far as can be judged of in children; coma, convulsions, and paralysis are frequent consequences. The ventricles of the brain are the chief seat of the watery accumulation. Bleeding from the temporal artery or jugular vein, cold applications to the head, and brisk purgatives with calomel, are the leading remedies.

Hydrocharidaceæ (Hydrocharis, one of the genera). A natural order of floating Endogens of the Hydral alliance, inhabiting Europe and some other places, known by their tripetaloideous flowers with an inferior ovary. They agree with *Alismaceæ* in habit and in want of albumen, but differ in their carpels being definite in number. They are not of any known use, but many of the species are handsome when in flower.

Hydrochloric Acid (Gr. ὕδωρ, and χλωρός, *pale*). A gaseous compound of 1 atom of chlorine = 36, and 1 atom of hydrogen = 1; the equivalent, therefore, of the hydrochloric acid is = 37. [MURIATIC ACID.]

Hydrocorisæ (Gr. ὕδωρ, and κορίς, *a bug*). The name of a tribe of Hemipterans, including the water-bugs; these differ from the *Geocorisæ*, or land-bugs, in having minute antennæ inserted beneath the eyes. This tribe includes the water-scorpions (*Nepidæ*) and the boat-men (*Notonectidæ*).

Hydrocotyle (Gr. ὕδωρ, and κοτύλη, *a cavity*). A curious little native Umbellifer, sometimes called Pennywort, remarkable for its round peltate leaves. It is reputed to be injurious to sheep, but probably without just cause, the marshy situations in which it grows being far more inimical to these animals.

Hydrocyanic Acid (Gr. ὕδωρ, and κύανος, *blue*). This noxious compound was first discovered by Scheele in 1782, and was called *Prussic acid*, but its real nature was not understood till the discovery of cyanogen by Gay Lussac in 1815. Its ultimate components are 2 atoms of carbon, 1 of nitrogen, and 1 of hydrogen. It is obtained by gently heating in a small retort a mixture of 3 parts of cyanide of mercury and 2 of hydrochloric acid. The evolved vapours should be passed through a tube containing fragments of marble, in order to absorb any hydrochloric acid that may chance to distil over, and ultimately condensed in a receiver immersed in a freezing mixture. The hydrocyanic acid is a colourless liquid, having a strong odour resembling that of bitter almonds; its specific gravity at 45° is 0·7. It boils at 80°, and freezes at 0°. Dissolved in a large quantity of water, it imparts to it the smell and taste of the laurel or bitter almond water; it is intensely poisonous—less than a grain of it has destroyed the life of an adult in twenty minutes. Largely diluted with water it is used in medicine as a sedative, and externally in chronic skin diseases. The dilute hydrocyanic acid of the London *Pharmacopœia* contains 2 per cent. of the real acid, and that sold under the name of Scheele's acid contains about 5 per cent. Of this, if not further diluted, from twenty to thirty drops would generally suffice to destroy the life of an adult. The antidotes to be used in cases of poisoning by this acid are chlorine, ammonia, cold affusion, and artificial respiration. (Taylor *On Poisons.*)

Hydrodynamics (Gr. ὕδωρ, and δύναμις, *power*). The science that applies the principles of dynamics to determine the conditions of motion, or rest, upon fluid bodies. It is usually divided into two branches; namely, *hydrostatics*, which explains the laws of the

equilibrium, pressure, and cohesion of fluids; and *hydraulics*, which explains the laws of their motion, together with the principles of the machines in which they are chiefly concerned. Though the term *hydrodynamics* is sometimes applied generally to fluids of all kinds, it is more usually confined to the non-elastic or incompressible fluids, such as water, mercury, &c.; in which case the science which treats of the equilibrium of the compressible and elastic fluids, like the air, is called *aërostatics*, and that which treats of their motion is called *pneumatics*.

Hydrodynamics, though a science of immense importance in its application to the various purposes of life, was not cultivated to any extent by the ancients, all their knowledge of the doctrine of fluids being limited to a few propositions regarding the pressure and equilibrium of water. Archimedes, indeed, established the general principles which serve as the foundations of hydrostatics in his treatise *De Insidentibus Humido* (περὶ τῶν ὕδατι ἐφισταμένων); and Ctesibius and Hero, who flourished at Alexandria about 120 years after Christ, invented the pump of compression, the siphon and the forcing pump, unless the siphon is to be considered a much more ancient invention, for the Egyptian hieroglyphics contain very correct representations of this instrument, and the Roman aqueducts of about 70 B.C. display the knowledge of the ancients in this matter. Julius Frontinus, who was inspector of the public fountains at Rome, in the time of Nerva and Trajan, wrote a work on the Roman aqueducts, and on the modes of distributing water then in use; but he appears to have been unacquainted with the law of the velocities of running waters depending on their depth. The first known modern treatise on Hydrodynamics was published, in 1639, by Castelli, a disciple of Galileo, under the title of *Della Misura dell' Acque Correnti*; and it contains a satisfactory explanation of various phenomena in the motion of fluids. Torricelli discovered the important property that the velocities of fluids, issuing through an orifice, is as the square roots of the pressure; Marriotte, in his *Traité du Mouvement des Eaux*, employed the principle of Torricelli, and explained the discrepancy between theory and observation by ascribing it to the retardation of the water's velocity arising from friction. Guglielmini was the first who treated of the motion of water in rivers and open channels. The subject of the oscillation of waves, one of the most difficult in the whole science, was first investigated by Sir Isaac Newton, who determined the duration of the oscillations, and thence concluded that the velocities of waves formed on the surface of water are in the subduplicate ratio of their size. He was also the first who observed the contraction in the vein of a fluid issuing through an orifice, and he regarded the contracted section as the true orifice, by which the theory of the escape of water was rendered more conformable to experience. The *Hydrodynamica* of Daniel Bernouilli was published in 1738. His theory of the motion of fluids consists in supposing, firstly, that the surface of a fluid in a vessel, while emptying itself by an orifice, remains unchanged, and always horizontal; and, secondly, that if the fluid may be conceived to be divided into an infinite number of horizontal strata, all the strata remain parallel, and descend vertically, with velocities inversely proportional to their breadth, or to the horizontal sections of their reservoirs. From these suppositions, and by means of the application of the principle of the conservation of living forces, he obtained solutions of the principal problems of hydrodynamics. The mathematical theory of the nature of fluids was further investigated by John Bernoulli, Maclaurin, and the celebrated D'Alembert, the latter of whom placed it in an entirely new light by the application of Euler's doctrine of partial differences. One of the best treatises on hydrodynamics which we possess, is that of the Abbé Bossut, in which are given the results of a very extensive set of experiments, performed with great judgment and accuracy. Similar and more extensively varied experiments were afterwards undertaken by Du Buat, whose *Principes d'Hydraulique*, in three volumes, contains a theory founded upon the results thus obtained. Du Buat was the first who ascertained the effect of heat in increasing the fluidity of bodies he experimented upon. Among the other researches more recently undertaken for the purpose of throwing light upon this difficult and interesting subject, we may mention those of Prony, Coulomb, Eytelwein of Berlin, Bidoni of Turin, Sabatier, Poncelet, Lesbros, Morin, George Rennie, Jardine of Edinburgh, Darcy, Belanger, Bazin, &c. From the four last-named authors, some valuable results with respect to the flow of water in pipes may be derived; Poncelet, Lesbros, and Morin principally turned their attention to the effect of various orifices upon the rate of discharge of water in channels.

The analytical theory of hydrodynamics resolves itself into the integration of equations of practical differences, a branch of the calculus which we owe to Euler, who gave the general formulæ for the motion of fluids, founded on the laws of their equilibrium, and thus reduced the whole question of the mechanics of fluid bodies to a simple one of analysis. If these formulæ could be integrated, we should be able to determine completely, in every case, all the circumstances of the motion and action of a fluid subjected to the influences of any forces whatever; but such is the difficulty of the subject, that the integration, except in a few limited cases, has hitherto resisted the efforts of the greatest mathematicians. Lagrange, in his *Mécanique Analytique*, had deduced the analytical formulæ of the motion of fluids from the principle of vertical velocities, and thus shown that dynamics and hydrodynamics are only branches

of one great principle, and results, as it were, of a single general formula. Laplace, in his *Mécanique Céleste*, has also given the general equations of hydrodynamics, and applied them to the questions of the figure of the earth, and of the tides. Since the days of those illustrious mathematicians, the theory has been illustrated, with reference to application to particular cases, by Poisson, Cauchy, Navier, Challis, Belanger, Weisbach, and others; but it cannot be said to have received any particular extension. Treatises on Hydrodynamics are very numerous. Besides the works of Lagrange and Laplace, and the others mentioned, we would refer the student to Bossut's *Hydrodynamique*; Poisson's *Mécanique*; Moseley's *Elementary Treatise on Hydrostatics and Hydrodynamics*; Jamieson's *Mechanics of Fluids*, &c. [HYDROSTATICS and HYDRAULICS.]

Hydrofluoric Acid. A highly corrosive and very volatile liquid, obtained by distilling in leaden or silver vessels a mixture of 1 part of *pure* fluor spar in fine powder with 2 of sulphuric acid. This compound acts vehemently upon glass and all silicious combinations; it is a compound of 19 fluorine + 1 hydrogen : = 20 hydrofluoric acid.

Hydrogen (Gr. ὕδωρ, and γεννάω, *I generate*). This important element is only known to us in the gaseous or permanently elastic form. It was formerly called *inflammable air*, and was sometimes considered as identical with *phlogiston*, or the matter of heat. It is usually procured by the action of sulphuric acid and zinc or iron upon water, or by passing the vapour of water over red-hot iron. Pure hydrogen is a colourless, tasteless, and inodorous gas. 100 cubic inches at mean temperature and pressure weigh 2·13 grains; so that its specific gravity compared with air is as 67 to 1,000, and it is exactly 16 times lighter than oxygen. It is therefore the lightest known form of matter, being 14·4 times lighter than air, and 11,000 times lighter than water. It burns in contact with air with a pale flame; and when mixed with three or four times its volume of air, or with half its volume of pure oxygen, and inflamed, it burns rapidly, and in the latter case with violent explosion. The only product of this combustion is *water*, which is thus shown to consist of 1 part by weight of hydrogen with 8 of oxygen; so that upon this datum the number 8 becomes the equivalent of oxygen, and 9 that of water. Hydrogen is not absorbed by water, and animals soon die when confined in it.

Hydrography (Gr. ὕδωρ, and γράφω, *I write*). The description of the waters which exist at the surface of the earth, particularly with reference to the bearings of the coasts, the depths, currents, and other circumstances required to be known for the purposes of navigation. This term implies the same thing with regard to the sea that geography implies with regard to the land. *Hydrographical charts* or *maps* are projections of some part of the ocean, in which the meridians, parallels, &c., with the coasts, capes, rocks, shallows, &c., are laid down for the uses of navigation.

Hydrogurets or **Hydrurets.** Compounds of hydrogen with metals, &c. The term *hydride* is sometimes similarly used.

Hydroleaceæ (Hydrolea, one of the genera). A small group of Monopetalous Exogens, now included in *Hydrophyllaceæ*.

Hydrolite (Gr. ὕδωρ, *water*; λίθος, *a stone*). A name given to Gmelinite (Soda Chabazite), as containing a large quantity of water. It is a silicate of alumina, iron, and potash, containing nearly twenty per cent. of water, and has been found in the amygdaloidal rocks of Antrim in Ireland.

Hydrology (Gr. ὕδωρ, and λόγος). The part of the general science of Physical Geography that relates to the phenomena of water in the liquid form.

The principal part of the water on the globe occupies a large depression of the surface, and is denominated the OCEAN. Different parts of it are known as the PACIFIC, the ATLANTIC, the INDIAN, the ARCTIC, and the ANTARCTIC Oceans. The rest of the surface rises above the level of the ocean, or if depressed is occupied by waters that do not connect with the great body of the ocean.

The form of the land, or in other words the form of the line of intersection of the surface of the ocean with the land, is extremely irregular, the water entering the land at numerous recesses and the land projecting into the water by various promontories. The former are called INLAND SEAS, GULFS, or BAYS, according to the extent to which the water is land-locked. The waters reposing in hollows within the land are called LAKES, and the waters running along the surface to enter the ocean or the lakes or be lost in plains are called RIVERS. The rivers connect with each other, and form large and definite RIVER SYSTEMS, draining definite tracts of land.

The grand phenomena of the ocean include the regular TIDES and CURRENTS which affect it, the WINDS and STORMS which disturb it; its temperature, depth, and mineral contents. The phenomena of fresh water actually on the surface are quite distinct; and the phenomena of water in the atmosphere, including the falling and distribution of rain, belong to METEOROLOGY, another department of Physical Geography.

Few things connected with the laws of matter and their visible results on the earth are more striking than those which belong to the circulation of water around and through the earth. The warm air that floats above the surface of the ocean is constantly raising vapour, with which the atmosphere is charged to the extent of at least four parts out of five, being ready to give it off at the slightest change of temperature. When the air in this state impinges upon land, it becomes either more heated and therefore more absorbent (the additional supply being readily obtained), or chilled and less absorbent, and in a condition

to deposit moisture as rain. Thus on all high grounds, which are necessarily colder than the lowlands in the same latitude, and on all cooler latitudes to which clouds are drifted, there is occasional rain, often very heavy and continuous over large tracts. The rain that thus falls is partly, no doubt, reabsorbed into the air, or is used in the production of vegetable and animal tissue. A great part, however, runs along the earth's surface in streams and rivers, circulating at the surface visibly, and the rest enters the strata, pervades them, and passes through them invisibly from place to place, coming out again in springs, and completing another circulation out of sight.

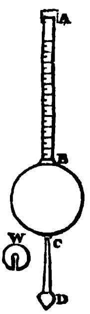
The influence of water is felt everywhere, and all the phenomena of structure observable in rocks of every kind are influenced by this complete and never-ceasing circulation.

Hydrology is thus a department of great importance and interest. The details will be found considered in various separate articles, of which the names are printed in the above paragraphs in capital letters.

Hydromancy (Gr. ὑδρόμαντις, *a water-prophet*). Among the ancients, a method of divination by water. It was performed in various ways. Its origin is ascribed by Varro to the Persians.

Hydromel (Gr. ὕδωρ, and μέλι, *honey*). Water sweetened with honey, which when fermented forms *mead*.

Hydrometer (Gr. ὕδωρ, and μέτρον, *measure*). An instrument for determining the specific gravities of liquids, and thence also the strengths of spirituous liquors. Various instruments of different forms have been proposed for ascertaining readily the specific gravities of fluids; but Sikes's hydrometer, directed by Act of Parliament to be used in collecting the revenue of the United Kingdom, may be considered as deserving of description. This instrument is represented in the annexed figure. A B is a flat stem, divided on both sides into eleven equal parts, each of which is again subdivided into two. The stem carries a hollow brass ball B C, in which is fixed a conical stalk C D, terminating in a pear-shaped bulb D. Eight different weights of a circular form, and marked with the numbers 10, 20, 30, 40, 50, 60, 70, and 80, are cut in the manner represented at W, so that they can be placed on the stalk C D. When the strength of spirits is to be measured, one of the circular weights is placed on C D, which is found by trial to be capable of sinking the ball so far that the surface of the liquid cuts the stem at one of the divisions between A and B. The number of this division is then observed, and also the temperature of the liquid; and the corresponding strength per cent. of the spirit is then found in a table which accompanies the instrument. Glass hydrometers, adapted to various scales, are in constant use for determining the specific gravities of all kinds of liquids.



Jones's Hydrometer is an improvement on Sikes's. It has a square stem carrying a different scale upon each of its four sides, and is accompanied by three separate weights, which with the unweighted instrument correspond with the four scales.

Baumé's Hydrometer is much used on the Continent. In principle it does not differ from Sikes's. Its scale, however, is quite arbitrary; and as the gravities of liquids are frequently given in degrees Baumé in foreign books, the following tables will be found useful in translating these degrees into real specific gravities:

Table for the Reduction of Degrees of Baumé's Hydrometer to real Specific Gravities (water = 1). Liquids heavier than Water.

Degrees Baumé	Specific Gravities	Degrees Baumé	Specific Gravities	Degrees Baumé	Specific Gravities	Degrees Baumé	Specific Gravities
0	1·000	20	1·152	39	1·345	58	1·617
1	1·007	21	1·160	40	1·357	59	1·634
2	1·013	22	1·169	41	1·369	60	1·652
3	1·020	23	1·178	42	1·382	61	1·670
4	1·027	24	1·188	43	1·395	62	1·689
5	1·034	25	1·197	44	1·407	63	1·708
6	1·041	26	1·206	45	1·421	64	1·727
7	1·048	27	1·216	46	1·434	65	1·747
8	1·056	28	1·226	47	1·448	66	1·767
9	1·063	29	1·236	48	1·462	67	1·788
10	1·070	30	1·246	49	1·476	68	1·809
11	1·078	31	1·256	50	1·490	69	1·831
12	1·086	32	1·267	51	1·505	70	1·854
13	1·094	33	1·277	52	1·520	71	1·877
14	1·101	34	1·288	53	1·535	72	1·900
15	1·109	35	1·299	54	1·551	73	1·924
16	1·118	36	1·310	55	1·567	74	1·949
17	1·126	37	1·322	56	1·583	75	1·974
18	1·134	38	1·333	57	1·600	76	2·000
19	1·143						

Table for the Reduction of the Degrees of Baumé's Hydrometer for Liquids lighter than Water.

Degrees Baumé	Specific Gravities	Degrees Baumé	Specific Gravities	Degrees Baumé	Specific Gravities	Degrees Baumé	Specific Gravities
10	1·000	23	·918	36	·849	49	·789
11	·993	24	·913	37	·844	50	·785
12	·986	25	·907	38	·839	51	·781
13	·980	26	·901	39	·834	52	·777
14	·973	27	·896	40	·830	53	·773
15	·967	28	·890	41	·825	54	·768
16	·960	29	·885	42	·820	55	·764
17	·954	30	·880	43	·816	56	·760
18	·948	31	·874	44	·811	57	·757
19	·942	32	·869	45	·807	58	·753
20	·936	33	·864	46	·802	59	·749
21	·930	34	·859	47	·798	60	·745
22	·924	35	·854	48	·794		

Twaddell's Hydrometer is much used by English chemical manufacturers for testing liquids heavier than water. Its degrees are converted into ordinary specific gravities by multiplying them by 5, adding 1000, and dividing the sum by 1000. Thus

$$20° \text{ Twaddell} = \frac{20 \times 5 + 1000}{1000} = 1{\cdot}100.$$

Another easy method of determining the densities of different liquids, sometimes practised, is by means of a set of glass beads previously adjusted and numbered. Thrown into any liquid, the heavier balls sink and the lighter float at the surface; but one of them approaching the density of the liquid will be in a state of indifference as to buoyancy, or will float under the surface. The number on this ball indicates, in thousandth parts, the specific density of the liquid.

Hydrometra (Gr. ὕδωρ, and μήτρα, *the womb*). Dropsy of the uterus.

Hydrometridæ (Gr. ὕδωρ, and μήτρα). A family of *Geocorisæ*, or land-bugs, but of aquatic habits; not, however, living in water, but frequenting the surface.

Hydropathy (Gr. ὕδωρ, and πάθος, *disease*). This term is applied to a treatment of disease generally called the *cold-water cure*; it was suggested, in 1828, by Vincent Priessnitz of Graefenberg in Silesia, and consists in the internal and external administration of cold water, accompanied by air and exercise, early hours, and strict attention to diet; there are, therefore, many cases in which such a plan rationally pursued must be obviously useful, more especially to overphysicked individuals, residing in populous towns, eating and drinking too much, and keeping bad hours. At the same time, some parts of the treatment are by some considered to be 'of so outrageous a character as frequently to aggravate the disease which they are intended to cure, and occasionally to endanger the life of the patient.'

Hydropericardium (Gr. ὕδωρ, and περικάρδιον, *about the heart*). Dropsy of, or an unnatural accumulation of watery fluid in, the sac of the heart.

Hydrophane (Gr. ὕδωρ, and φαίνω, *I show*). A variety of opal, which is white and opaque when dry, but becomes translucent in water.

Hydrophides (Gr. ὕδωρ, and ὄφις, *a serpent*). A name applied to the section of *Ophidians*, including the water-snakes. These are principally distinguished by having the tail compressed or flattened sideways, for the purpose of swimming. They are armed with poison fangs; but these are of small size, and are associated with a row of non-venomous maxillary teeth.

Hydrophilidæ (Gr. ὕδωρ, and φιλέω, *I love*). A family of Pentamerous Coleopterans, including those species which have short clavate antennæ, long and slender palpi, mandibles bidentate at the tips; body oval and convex; and the hind-legs often ciliated. The *Hydrophilidæ*, like the *Dyticidæ*, are aquatic beetles, and have wings by which they can transport themselves from one piece of water to another; but they are vegetable-feeders, and are less active in their movements than the predatory water-beetles. The family includes many genera. The typical species, *Hydrophilus caraboides*, is common in the stagnant ponds and ditches of this country.

Hydrophobia (Gr. ὑδροφοβία, *dread of water*). A disease remarkably characterised by alarm at the approach of water, and caused by the bite of a mad dog or other rabid animal; but it does not appear capable of being communicated by the human subject. At some indefinite period after the bite, and often long after all local injury has healed, itching and pain in the bitten part, heaviness, great restlessness and uneasiness, and mental alarm ensue, followed by pains about the neck, sense of choking, and great irritability and horror at any attempt to drink, although solid food can generally be swallowed. Fever, vomiting, excessive thirst, spitting of viscid saliva, and difficult respiration then come on, with irregular pulse and convulsions, under which the sufferer sinks more or less rapidly according to the strength of his constitution. Delirium sometimes precedes death, but not always; in many instances the judgment appears unaffected. It unfortunately happens that nothing in the way of cure, and little even as palliation, has been successfully effected in this disease; but there appears little doubt that the timely application of preventive measures has been successful, and of these the amputation or excision of the bitten part, and the application of caustics to it, or both united, are most to be relied on; and the sooner they are resorted to the better the chance of success, but it appears that they may be effective any time before the appearance of symptoms. Among caustics, the nitric acid is perhaps the most effective. It energetically acts upon and decomposes all animal matter, and fluids more especially: and if applied very soon after the bite, can scarcely fail to be effective: it also penetrates the wound, and forms a sloughing sore. The appearance of madness in dogs, in its early stages at least, is unfortunately not very well defined, nor always easily distinguishable from their other maladies: whether the bite is less dangerous before they become evidently rabid than afterwards, seems to be doubtful. In general the animal is observed to be unusually dull and unsociable, refuses food, hangs his head, and appears drowsy: he flies at strangers, but usually recognises his master, though with comparative indifference. Afterwards his breathing is quick and heavy; frothy matter runs from his mouth; he walks slowly, but occasionally runs and starts forward; at length he forgets his master, often falls down, flies at everybody in his way, grows furious, and in four-and-twenty or thirty hours dies.

Hydrophyllaceæ (Hydrophyllum, one of the genera). A natural order of herbaceous Exogens, inhabiting America and belonging to the Cortusal alliance. They come very near to *Boraginaceæ*, from which they are known by their one-celled, many-seeded fruit, and other characters. Some *Polemoniaceæ* have the habit of this order. The species of *Eutoca* and *Phacelia* are often cultivated on account of their pretty flowers.

Hydrophytes (Gr. ὕδωρ, and φυτόν, *a plant*). Plants which thrive in water; as

given by botanists to algaceous plants, and sometimes confined to those which are found in fresh water. It has been remarked by Lyell (*Principles of Geology*) that the number of hydrophytes is very considerable, and their stations more varied than could have been anticipated; for while some plants are daily covered and uncovered by the tide, others live in abysses of the ocean at the extraordinary depth of 1,000 feet; and although such situations must be profoundly dark, at least to our organs, many of these vegetables are highly coloured.

Hydrops (Gr. ὕδρωψ). Dropsy. An unnatural accumulation of fluid in the cellular membrane or cavities of the body.

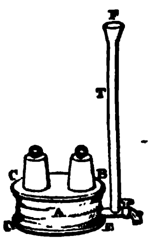
Hydropthalmia (Gr. ὕδωρ, and ὀφθαλμος, *the eye*). Dropsy of the eye.

Hydrorachitis (Gr. ὕδωρ, and ῥάχις, *the spine*). A tumour upon the spine of infants; at first of a blue colour, but afterwards becoming translucent; it is attended with paralysis of the lower limbs, and is usually fatal in its consequences.

Hydroscope (Gr. ὑδροσκόπιον, from ὕδωρ, and σκοπέω, *I view*). An instrument anciently used for measuring time by means of the flowing of water through a small orifice. It consisted of a cylindrical tube, conical at the bottom. The cylinder was graduated; and as the water trickled out at the apex of the cone, its surface became successively contiguous to the divisions marked on the cone, and thereby pointed out the hour.

Hydrostatic Balance (Gr. ὑδροστάτης). A balance for weighing substances in water, for the purpose of ascertaining their specific gravities.

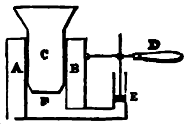
Hydrostatic Bellows. An apparatus for illustrating the *hydrostatic paradox*, or that peculiar property of liquids in virtue of which they transmit pressure equally in every direction.



In the annexed figure B C and D E are two flat boards united by leather or flexible cloth A, water-tight. A short tube fitted with a stop-cock communicates with the interior of the bellows, by which the liquid may be discharged. From the short tube a long tube T rises perpendicularly, and terminates in a funnel F. The upper board BC is loaded with weights, which press it against the lower board D E. On pouring water into the funnel F it will descend through the tube T, and enter between the boards; and by continuing the supply a column will be formed in the tube, the weight of which, transmitted through the water in the bellows, will raise and support the weights on the board.

Hydrostatic Paradox. A term frequently employed to designate that principle in hydrostatics according to which any quantity of water, however small, may be made to balance any weight, however great. [Hydrostatic Bellows.]

Hydrostatic Press, also called the **Hydraulic Press,** and sometimes, from the name of the engineer who gave it the form under which it is now constructed, and brought it into general use, **Bramah's Press.** A machine by means of which an enormous force or pressure is obtained through the medium of water. The principle is the same as that of the *hydrostatic bellows*; from which, indeed, it only differs by the substitution of a strong forcing pump for the long tube, and a barrel and piston for the leather and boards. It consists of a short and very strong pump-barrel A B, with a solid piston C of proportionate strength, which is pushed upwards against the thing to be compressed by water driven into the barrel beneath it at F from the small forcing pump E.



If the small pump have only one-thousandth of the area of the large barrel, and if a man by means of its lever handle D press its piston down with a force of 500 pounds, the piston of the great barrel, in virtue of the hydrostatic principle of equal pressure in all directions, will rise with a force of a thousand times 500 pounds, or more than 200 tons. The hydrostatic press is applied to a great variety of useful purposes; for compressing bales of goods, as paper, cotton, wool, tobacco, &c.; for expressing oils from seeds, raising weights, uprooting trees, &c.

Hydrostatica. The name of an order of *Acalephes*, including those which have one or more air-vessels appended to their body.

Hydrostatics. The science which explains the properties of the equilibrium and pressure of liquids. It is the application of statics to the peculiar constitution of water or other bodies existing in the perfectly liquid form.

The whole doctrine of the equilibrium and pressure of liquids is deduced from the following fundamental law: 'When a liquid mass is in equilibrium under the action of forces of any kind, every molecule of the mass sustains an equal pressure in all directions.'

One of the most obvious consequences of the above law is, that the surface of a liquid when at rest in an open vessel, and acted upon by no other force than gravity, is horizontal, or perpendicular to the direction of gravity. If the directions of gravity are parallel, the surface will consequently be a plane; if they converge to a point, the surface of the liquid will be a portion of a sphere. Stagnant water at the surface of the earth, therefore, assumes the spherical figure; but by reason of the magnitude of the sphere the curvature of any small portion of it is insensible, and the surface may be regarded as a plane. A ring surrounding the earth would bend away from a perfectly straight line only eight inches in a mile.

If a free communication is made between two or more vessels containing a liquid by

[illegible] or otherwise, the surface of the liquid when in equilibrium will always stand at the same level.

The liquid contained in a vessel being at rest, and subjected to the action of gravity only, any particle of it is pressed in all directions (vertically, horizontally, or obliquely) by a force which is equal to the weight of the vertical column of the liquid incumbent on it.

Instead of a particle of the liquid itself, we may consider the column to rest on an indefinitely small portion of the bottom or the sides of the vessel in which it is contained, and it will follow that the pressure on an indefinitely small portion of the area at any point of the bottom or sides is perpendicular to the plane of that area, and equal to the weight of a vertical column of the liquid standing on it as a base and reaching to the surface. Hence the whole pressure sustained by any finite portion of the bottom or sides of the vessel is equal to the weight of a column of the liquid having for its base the surface pressed on (extended into a plane if necessary), and for its altitude the distance of the centre of gravity of that surface from the surface of the liquid.

The point of a plane surface at which the resultant of all the liquid pressures upon it is applied, is called the *centre of pressure.* From the above it follows that the pressure on the bottom of the vessel depends only on the magnitude of the bottom and the depth of the liquid, and is entirely independent of the form of the sides and of the quantity of liquid in the vessel. It is on this principle that the *hydrostatic press* and *hydrostatic bellows* are constructed. A body immersed in a liquid is pressed upwards by a force equal to the weight of the liquid it displaces; and the difference between the absolute weight of a body and its weight when entirely immersed, is the same with the weight of a quantity of the liquid equal in bulk to the body. The *specific gravity* of a body, therefore, being the ratio of its own weight to that of an equal volume of water, may at once be found by weighing it first in air and then in water. The equilibrium of solid bodies floating on liquids, a subject discussed by Archimedes in his treatise *De Humido Insidentibus,* is an important part of hydrostatics in consequence of its relation to the construction and stowage of ships. A body placed on a fluid specifically heavier than itself, will sink so far that the weight of the fluid displaced is equal to the whole weight of the body; and when it assumes the position of equilibrium, the line which joins the centre of gravity of the body and the *centre of buoyancy* (which is the same as the centre of gravity of the immersed part supposed to be homogeneous) is perpendicular to the surface of the water, or the horizon.

The centre of gravity of a body is a fixed point relatively to the body itself; but the centre of buoyancy, which depends on the figure of the immersed part, will change its place when the figure or relative situation of the immersed part undergoes any alteration. The character of the equilibrium of a floating body depends upon the relative positions of the centres of gravity and buoyancy with respect to a certain point called the *metacentre,* which latter may be defined as the point in which the line joining the centre of gravity with the centre of buoyancy, in the position of equilibrium, is intersected by the vertical through the centre of buoyancy corresponding to a slightly altered position of the body. The metacentre may in all cases be determined from the form and density of the body, and the equilibrium will be stable, neutral, or unstable, as it falls above, upon, or below the centre of gravity.

Hydrosulphates or **Hydr[illegible]sulph[illegible]** Compounds of hydrosulphuric acid or sulphuretted hydrogen.

Hydrosulphuric Acid. [SULPHURETTED HYDROGEN.] This compound has also been called *hydrothionic acid* (from hydrogen, and Gr. *θεῖον, sulphur*).

Hydrothorax (Gr. *ὕδωρ,* and *θώραξ, the chest*). Dropsy of the chest. The symptoms are: difficult breathing when in a recumbent posture, paleness, cough, thirst, swelling of the legs and feet, quick and often irregular or intermitting pulse. [DROPSY.]

Hydrozoa (Gr. *ὕδωρ*; *ζῶον, animal*). These are defined by the best zoologists as gelatinous, oblong, or conical animals with a contractile body, an intestinal cavity, and an oral aperture, which is surrounded by a circlet of arms or tentacles.

Hydruret or **Hydroguret.** A term applied in Chemistry to some of the compounds of hydrogen, more especially with the metals.

Hydrus (Gr. *ὕδρος*). A genus of water snakes, characterised by a compressed or laterally flattened tail adapted for swimming; and by having many maxillary teeth, like nonvenomous serpents, but with the first larger than the rest, and grooved for the transmission of a poison-duct. The species are confined to the seas of the warmer latitudes.

HYDRUS. In Astronomy. A southern constellation.

Hygieia (Gr. *ὑγίεια, health*). The goddess of health, in the Greek Mythology: daughter or wife of Asklepios (Æsculapius). Her statues (of which the most celebrated was at Sicyon) sometimes represented her with a large serpent coiled round her body, and elevating its head above her arm to drink of a cup which she held in her hand. Isis, in Egyptian monuments, appears sometimes in a similar attitude.

Hygiene. That branch of medicine which relates to the means of preserving public health.

Hygrology (Gr. *ὑγρός, moist,* and *λόγος*). In Medicine, the doctrine of the humours or fluids of the body.

Hygroma (Gr. *ὑγρός*). A tumour containing serum or other non-purulent fluid.

Hygrometer (Gr. *ὑγρός,* and *μέτρον, measure*). An instrument for measuring the degrees of moisture or dryness of the atmosphere.

Variations in the state of the atmosphere with respect to moisture and dryness are manifested by a great variety of phenomena; and accordingly numerous contrivances have been proposed for ascertaining the amounts of those variations by referring them to some conventional scale. All such contrivances are called *hygrometers*; but though the variety of form that may be given to them, or of substances that may be employed, is endless, they may all be referred to two classes; namely, 1st, those which act on the principle of *absorption*; and, 2nd, those which act on the principle of *condensation*.

1. *Hygrometers on the Principle of Absorption.*—Many substances in each of the three kingdoms of nature absorb moisture from the atmosphere with greater or less avidity, and thereby suffer some change in their dimensions, or weight, or some of their physical properties. Animal fibre is softened and relaxed, and consequently elongated, by the absorption of moisture. Cords composed of twisted vegetable substances are swollen, and thereby shortened, when penetrated by humidity; and the alternate expansion and shrinking of most kinds of wood, especially when used in cabinet work, and after the natural sap has been evaporated, is a phenomenon with which everyone is familiar. Many mineral substances absorb moisture readily, and thereby obtain an increase of weight. Now it is evident that any of these changes, either of dimension or of weight, may be regarded as the measure of the quantity of moisture absorbed, from which the quantity of water existing in the atmosphere in the state of vapour is inferred; but many, indeed the far greater part of them, are so small in amount, or take place so slowly, that they afford no certain indication of the actual state of the atmosphere at any particular moment. In fact, all contrivances which depend upon absorption have been successively abandoned as incapable of affording reliable indications.

2. *Hygrometers on the Principle of Condensation.*—The instruments of this class are of a far more refined nature than those which we have been describing. In order to give an idea of the general principle on which they depend, let us conceive a glass jar, having its sides perfectly clean and transparent, to be filled with water, and placed on a table in a room where the temperature is, for example, 60°, the temperature of the water being the same as that of the room. Let us next suppose pieces of ice, or a freezing mixture, to be thrown into the water, whereby the water is gradually cooled down to 55, 50, 45, &c. degrees. As the process of cooling goes on, there is a certain instant at which the jar loses its transparency, or becomes dim; and on attentively examining the phenomenon, it is found to be caused by a very fine dew or deposition of aqueous vapour on the external surface of the vessel. The precise temperature of the water, and consequently of the vessel, at the instant when this deposition begins to be formed, is called the *dew point*, and is capable of being noted with great precision. Now this temperature is evidently that to which, if the air were cooled down, under the same pressure, it would be completely saturated with moisture, and ready to deposit dew on any body in the least degree colder than itself. The difference, therefore, between the temperature of the air and the temperature of the water in the vessel when the dew begins to be formed, will afford an indication of the dryness of the air, or of its remoteness from the state of complete saturation.

But the observation which has now been described is capable of affording far more interesting and precise results than a mere indication of the comparative dryness or moisture of the atmosphere. With the help of tables of the elastic force of aqueous vapour at different temperatures, it gives the means of determining the absolute weight of the aqueous vapour diffused through any given volume of air, the proportion of vapour existing in that volume to the quantity that would be required to saturate it, and of measuring the force and amount of evaporation.

The elastic force of aqueous vapour at the boiling point of water is evidently equal to the pressure of the atmosphere. This may be assumed as corresponding to a column of mercury 30 inches in height. Dr. Dalton, in the fifth volume of the *Manchester Memoirs*, has given the details of a valuable set of experiments by which he ascertained the elastic force of vapour from water at every degree between its freezing and boiling points, in terms of the column of mercury which it is capable of supporting. As the same experiments have since been frequently repeated, and the different results present all the accordance which can be expected in so delicate an investigation, the tension of vapour at the different temperatures may be regarded as sufficiently well determined. Supposing, then, we have a table exhibiting the elasticity or tension corresponding to every degree of the thermometer, the weight of a given volume of vapour, for example a cubic foot, may be determined as follows:—

Steam at 212°, and under a pressure of 30 inches of mercury, is 1,700 times lighter than an equal bulk of water at its greatest density, or a temperature of about 40°, and a cubic foot of water at that temperature weighs 437,272 grains; the weight, therefore, of a cubic foot of steam at that temperature and pressure is $437{,}272 \div 1{,}700 = 257 \cdot 218$ grains. Hence we may find the weight of an equal bulk of vapour of the same temperature under any other given pressure, suppose 0·56 of an inch; for the density being directly as the pressure, we have 30 in. : 0·56 in. : : 257·218 grs. : 4·801 grs., which is the weight required.

Having found the weight of a cubic foot of vapour under a pressure of 0·56 of an inch, and at the temperature 212°, we may find its weight under the same pressure at any other temperature, suppose 60°. It is ascertained by experiment that all aëriform bodies, whether vapours or gases, expand the 1-480th part of

their volume for every accession of temperature equivalent to one degree of Fahrenheit's scale; therefore, reckoning a volume of gas at 32° as unity, its volume at 60° is to its volume at 212° as $1 + \frac{28}{480}$ is to $1 + \frac{180}{480}$; or as 1·058 : 1·375; and the density and weight being inversely as the volume, we have

$$1{\cdot}058 : 1{\cdot}375 :: 4{\cdot}801 \text{ grs.} : 6{\cdot}222 \text{ grs.}$$

for the weight of a cubic foot of vapour at temperature 60°, and under a pressure of 0·56 of an inch of the mercurial column.

The following table, abridged from Daniell's *Meteorological Essays*, shows the force or tension, weight, and expansion of aqueous vapour, at different temperatures on Fahrenheit's scale:—

Temp.	Force	Weight of a Cubic Foot	Expansion
0	·068	·856	·9334
5	·083	1·034	·9438
10	·098	1·208	·9542
15	·119	1·451	·9646
20	·140	1·688	·9750
25	·170	2·028	·9855
30	·200	2·361	·9959
35	·240	2·805	1·0062
40	·280	3·239	1·0166
45	·340	3·893	1·0270
50	·400	4·535	1·0375
55	·476	5·342	1·0479
60	·560	6·222	1·0583
65	·657	7·230	1·0687
70	·770	8·392	1·0791
75	·906	9·780	1·0895
80	1·060	11·333	1·1000
85	1·235	13·081	1·1104
90	1·430	15·005	1·1208
95	1·636	17·009	1·1312
212	30·000	257·218	1·3749

Having explained the principle of the condensation hygrometer, we will now describe one or two of the forms under which it has been most frequently constructed. Daniell's hygrometer is represented in the annexed

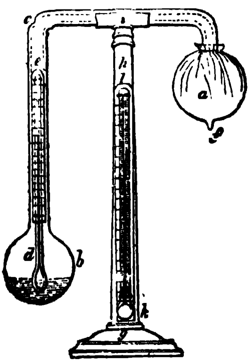


figure. *a* and *b* are two thin glass balls of 1¼ inch diameter, connected together by a tube having a bore about one-fourth of an inch. The tube is bent at right angles over the two balls, and the arm *b c* contains a small thermometer *d e*, whose bulb, which should be of a lengthened form, descends into the ball *b*. This ball having been about two-thirds filled with ether, is heated over a lamp till the fluid boils, and the vapour issues from the capillary tube *f* which terminates the ball *a*. The vapour having expelled the air from both balls, the capillary tube is hermetically closed by the flame of a lamp. The other ball *a* is now to be covered with a piece of muslin. The stand *g h* is of brass, and the transverse socket *i* is made to hold the glass tube in the manner of a spring, allowing it to turn and be taken out with little difficulty. A small thermometer *k l* is inserted into the pillar of the stand. The manner of using the instrument is this: After having driven all the ether into the ball *b* by the heat of the hand, it is to be placed at an open window, or out of doors, with the ball *b* so situated that the surface of the liquid may be on a level with the eye of the observer. A little ether is then to be dropped on the covered ball. Evaporation immediately takes place, which, producing cold upon the ball *a*, causes a rapid and continuous condensation of the ethereal vapour in the interior of the instrument. The consequent evaporation from the included ether produces a depression of temperature in the ball *b*, the degree of which is measured by the thermometer *d e*. This action is almost instantaneous, and the thermometer begins to fall in two seconds after the ether has been dropped. A depression of 30° or 40° is easily produced, and the ether is sometimes observed to boil and the thermometer to be driven below zero of Fahrenheit's scale. The artificial cold thus produced causes a condensation of the atmospheric vapour upon the ball *b*, which first makes its appearance in a thin ring of dew coincident with the surface of the ether. The degree at which this takes place must be carefully noted. In very damp or windy weather the ether should be very slowly dropped upon the ball, otherwise the descent of the thermometer will be so rapid as to render it extremely difficult to be certain of the degree. In dry weather, on the contrary, the ball requires to be well wetted more than once, to produce the requisite degree of cold. (Daniell's *Meteorological Essays.*)

A modification of Daniell's hygrometer has been proposed by Regnault, and is known as *Regnault's hygrometer.* In this instrument air is drawn through a silver-coated glass tube containing ether. The evaporation of the ether caused by the current of air produces the necessary depression of temperature, and the first deposition of dew is readily seen upon the polished silver surface. A thermometer, the bulb of which is always immersed in the ether, gives the temperature of the dew point, as in Daniell's hygrometer.

Of the various methods which have been proposed for ascertaining the hygrometric condition of the atmosphere. that which consists in deducing the tension of the aqueous vapour

contained in it from the temperatures indicated by two contiguous thermometers, one having its bulb kept wet, while that of the other is dry, is, perhaps, the most generally convenient, and is accordingly that which is usually adopted in meteorological observations. The apparatus has been called a *psychrometer*, though the term, from its etymology, might be applied with equal propriety to any other hygrometer or instrument for measuring the quantity of vapour existing in air.

The relation between the tension, or the elastic force of aqueous vapour, and the temperature (a relation which is the subject of experiment) is supposed to be known for all temperatures under consideration, and exhibited in a table. Hence, to determine the elastic force of the vapour existing in the atmosphere at a given temperature, is the same problem as to determine the degree of temperature to which, if the air were cooled down, it would be saturated with the same quantity of vapour as it actually contains, and begin to deposit moisture; and, reciprocally, if this temperature, which is that of the *dew point*, be determined, the tension of the vapour existing in the air becomes known from the previously ascertained relation between the tension and the temperature of aqueous vapour. Tables of the numerical expression of this relation were constructed by Dalton, and are given in most works which treat of the subject. [VAPOUR.]

Objections of various kinds, theoretical and practical, have been raised to the results obtained by this method. The fundamental principle adopted by August is, that the whole of the air which supplies heat to the wet bulb falls to the temperature of that bulb, and becomes completely saturated with moisture. But it seems more probable that the air coming into contact with the bulb does not quite take the temperature of the bulb, and that the saturation is not complete. Regnault remarks that the ratio of the quantity of heat which the air takes from the bulb by the vaporisation of the water to the quantity which it loses in being cooled is probably not constant, but so much the greater as the air is drier, because dry air absorbs moisture with greater avidity than when it is nearly saturated. Another objection is that the heat which is absorbed in converting the water on the wet bulb into vapour is not supplied exclusively by the surrounding air, but in some measure by the radiation from objects around (for example, the frame to which the thermometers are attached, or the dry bulb itself if too near), the influence of which it is perhaps impossible altogether to eliminate. Other objections are founded on the considerable uncertainty as to the numerical values of some of the elements which enter into the formula, and especially with respect to the heat absorbed by water when vaporised in air. Regnault, therefore, considers that the safest course is to determine the coefficients of the formula by direct experiments under determinate conditions. One means of accomplishing this is to compare the results of a large number of observations with the temperatures of the dew point ascertained directly by simultaneous observations with a Daniell's hygrometer; but as this instrument itself cannot be relied on with certainty, the only sure method would seem to be that of separating the moisture from the air and determining their proportions by actually weighing them.

The formula for computing the temperature of the dew point, from observations of a dry and wet bulb thermometer, was first investigated by Professor August, of Berlin, and is given in his work *Ueber die Fortschritte der Hygrometrie* (Berlin 1830), the same in form as the above, but with slightly different constants. There is also an investigation on the same principle, and leading to the same results, by Dr. Apjohn, in the Dublin *Transactions* for 1834 and 1835, and tables have been constructed by Colonel Boileau for facilitating the computation of the formula. But the fullest and best information on the subject is contained in a paper by Regnault, published in the *Annales de Chimie et de Physique* (3me series, tome xv. Paris 1845).

Hygrometric. This term is commonly applied to substances which readily become moist and dry with corresponding changes in the state of the atmosphere, or which readily absorb and retain moisture. Seaweed, several saline substances, porous clays, potash and its carbonate, chloride of calcium, sulphuric acid, are in this sense of the term said to be hygrometric.

Hygroscope (Gr. ὑγρός, and σκοπέω, *I view*). An instrument by means of which changes in the condition of the atmosphere with respect to moisture are observed. See HYGROMETER, by which the same changes are measured.

Hylæosaurus (Gr. ὕλη, *wood*, and σαῦρος, *a lizard*). A name given by Dr. Mantell to an extinct gigantic genus of reptiles, the fossil remains of which he has discovered in the wealden strata of Sussex.

Hylism (Gr. ὕλη). In Metaphysics, the theory which regards matter, as the original principle of evil, in opposition to the good spirit. This theory lay at the root of the Manichæan philosophy: it reappears under a slightly different form in Parseeism, which holds that the universe was created by two rival powers, Ormuzd and Ahriman, or Light and Darkness, the latter producing some evil thing for every good thing made by the former. [DUALISM; VRITRA.]

Hylobius (Gr. ὕλη, and βίος, *life*). A genus of Tetramerous Coleoptera, belonging to the *Curculionidæ*, or family of weevils, and noted for the ravages committed by one species, *Hylobius abietis* (*Curculio abietis* and *Curculio pini* of Linnæus), upon firs and larches, especially in young plantations. This insect varies from five to nine lines in length, is of a pitchy black colour, with numerous yellow spots on the elytra. It has been found in the pine woods

of Shropshire, the north of England, and Scotland.

Hylonomus (Gr. ὑλονόμος, *living in the woods*). A genus of probably Ganocephalous Reptilia, which has been discovered by Dr. Dawson in the carboniferous strata of the South Joggins coalfield, in Nova Scotia. The remains were found with those of a land-snail, a myriapodous annelide, a small ganocephalous reptile, the *Dendrerpeton acadianum*, with other fossils in the hollow trunk of one of the fossil trees or *Sigillariæ* of the coal deposits. The remains of *Hylonomus*, of which the jaws, dermal covering, and phalangeal bones have been satisfactorily identified, indicate the existence of a reptile during the carboniferous age allied in its general affinities to *Archegosaurus* and the *Ganocephala*.

Hylozoism (Gr. ὕλη, *wood*, used by ancient philosophers to signify the abstract idea of matter, and ζωή, *life*). In Philosophy, strictly the doctrine that matter lives. Some writers have confined this name to the tenet of the *anima mundi*, or soul of the world; others to the theory of a peculiar life residing in the whole of nature, approaching, therefore, in this sense to pantheism. This life is either merely organic or actually sentient: the latter notion has been also called *hylopathism*. (See the remarks on Cudworth's Intellectual System in Hallam's *Literature of Europe*, iv. 188; and Ersch and Gruber's *Encyclopædia*.)

Hymen (Lat.; Gr. Ὑμήν). In Greek Mythology, the god of marriage: represented in the earlier traditions as originally a mortal. The reasons for his invocation are very variously given; some saying that it arose from the happiness of his marriage, others attributing it to a desire of avoiding the evil omen of his death on the day of his marriage. *Hymeneal* is used to signify a song or ode composed in celebration of a marriage. (Cat. *Carm.* 61, 62.)

Hymenæa (Lat. from Hymen). The West Indian Locust-tree, or Algaroba, belongs to this genus of *Leguminosæ*. It is called *H. Courbaril*, and forms an enormous tree, remarkable for the buttresses naturally formed at the base of its stem. The timber is hard and close-grained; and the bark, which is thick but light, is used by the Indians for making canoes; while a valuable resin, resembling Anime, exudes from the trunk.

Hymenium. In Botany, a term used, in describing fungi, to denote that part in which the sporules immediately lie. It is commonly called the *gills* in the genus *Agaricus*; but in *Boletus* it is a corky or spongy substance pierced full of holes, and in other genera presents a variety of peculiar appearances.

Hymenopterans, Hymenoptera (Gr. ὑμήν, *a membrane*, and πτέρον, *a wing*). An order of mandibulate insects, comprehending those which have four membranous wings with few nervures. Latreille divides this order into the following sections and tribes:—

1. Terebrantia: Abdomen of the females furnished with a saw or borer.
   - *a.* Securifera: Abdomen sessile, furnished with a saw; larvæ with feet.
   - *b.* Pupivora: Abdomen pedunculated, furnished with a borer; larvæ footless.
2. Aculeata: Abdomen of the females armed with a sting.
   - *a.* Heterogyna: Females wingless.
   - *b.* Fossores: Females winged, wings not folded; basal joint of posterior tarsi simple.
   - *c.* Diploptera: females winged, wings folded.
   - *d.* Mellifera: Females winged, wings not folded; posterior tarsi enlarged, and converted into a pollinigerous organ.

(See the above terms; and Apis and Formica.)

Hymn (Gr. ὕμνος). An ode in praise of the Deity, or some divine personage. The earliest Greek hymns are those which are commonly known as the Homeric hymns. They are, with one exception, in heroic verse, and their contents, for the most part, are narrations of the events in the mythological history of the respective gods and goddesses to whom they are dedicated, related in an encomiastic strain. In modern literature, hymns are pieces of sacred poetry intended to be sung in churches; of which the Psalms of David, the most ancient pieces of poetry, properly so called, on record (except the book of Job), furnish the chief example and model. St. Hilary, bishop of Poitiers in the fourth century, is said to have been the first who composed hymns to be sung in churches. The Latin hymns of the Roman Catholic church are well known, from the exquisite music to which they have been united. (As to the classical hymns and hymnographers, see the *Mém. de l'Acad. des Inscr.* vols. xii. and xvi.)

Hyoides (from the Greek letter υ, and εἶδος, *likeness*). A bone situated between the root of the tongue and the larynx is called the *os hyoides*, or hyoid bone, from its supposed resemblance in shape to the letter υ or upsilon.

Hyoscyamia. The active principle or alkaloid of the common henbane (*Hyoscyamus niger*).

Hyoscyamus (Gr. ὑοσκύαμος, literally *hog-bean*). The genus of the Henbane, which is *H. niger*. It belongs to the *Solanaceæ*. [Henbane.]

Hypæthral (Gr. ὑπαίθριος, from ὑπό, and αἰθήρ, *ether*). In Architecture, a building or temple uncovered by a roof. The temples of this class are arranged by Vitruvius under the seventh order, having six columns in the front and rear, and being surrounded with a dipteral, or a double portico. The famous temple of Neptune at Pæstum, still remaining, is an example of this species of building.

Hypallage (Gr. ὑπαλλαγή, from ὑπαλλάσσω, *I change*). In Grammar and Rhetoric, a species of inversion, in which not only the natural or customary succession of words is changed, but the sense presents a species of transposition, in which predicates are transferred from their proper subject to another. Such examples as

'gladium vagina vacuum,' *the sword empty of the scabbard*, 'in nova fert animus mutatas dicere formas corpora,' where the adjective 'new' is transferred from 'form' to 'body,' present striking instances of this figure; but although such deviations from the natural sense could not be admitted in modern language, similar locutions are not wholly wanting among ourselves.

Hypanthium or **Hypanthodium** (Gr. ὑπό, and ἄνθος, *a flower*). In Botany, a fleshy receptacle not enclosed in an involucre.

Hypapophysis (Gr. ὑπό, and ἀπόφυσις, *a process*). In Anatomy, the usually exogenous process which descends from the lower part of the centrum or vertebral body: it is sometimes single, as in the cervical vertebræ of the lizard; sometimes perforated, as in certain cervical vertebræ of birds; sometimes double in a transverse pair, as in the caudal vertebræ of certain mammals, where they support the hæmal arch.

Hyper (Gr. ὑπέρ, *over, above*). In Chemical nomenclature, this prefix is sometimes used to denote acids containing more oxygen than those to which the term *per* is prefixed.

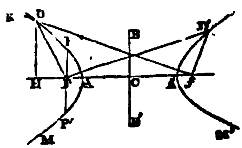
Hyper Space. In Geometry, imaginary space of more than three dimensions.

Hyperæmia (Gr. ὑπέρ, and αἷμα, *blood*). Congestion of blood in any part.

Hyperbola (Gr. ὑπερβολή). In Geometry, one of the conic sections, formed by cutting a cone by a plane which is so inclined to the axis that when produced it cuts also the opposite cone, or the cone which is the continuation of the former on the opposite side of the vertex. [CONIC SECTIONS.]

The hyperbola is also a curve of the second order, characterised by having two real and distinct asymptotes. [QUADRIC.] The ordinary definition of the hyperbola is as follows:—

If two points F and f be given in a plane, and a point D be conceived to move around them in such a manner that the difference between the two distances DF and Df is always constant, the point D will describe on the plane an hyperbola DAM. The two symmetrical



branches of which the curve consists are obtained by assuming first one of the given points F, and then the other f, as that to which the moving point is nearest. The points F and f are the *foci* of the hyperbola; and C, which bisects the distance between the foci, is its *centre*. The line AA′ is the *major* or *transverse axis*, its extremities A and A′ the *vertices*, and a straight line BB′, passing through the centre, perpendicular to AA′, and of such a length that the square of its half CB or CB′ is equal to the difference between the squares of CF and CA, is the *minor* or *conjugate* axis. The curve may be described mechanically as follows: Let one end of a string be fastened to F, and the other to K, the extremity of a ruler fDK; and let the difference between the length of the ruler and of the string be equal to AA′. Let the other end of the ruler be fixed to the point f, and let the ruler be made to revolve about f as a centre in the plane in which the axes are situated, while the string is stretched by means of a pin D, so that the part of it between K and D is applied close to the edge of the ruler: the point of the pin will, by its motion, trace a branch DAM of the hyperbola required; and if the ruler be made to revolve about the other focus F, while the end of the string is fastened to f, the opposite branch of the hyperbola will be described by the pin D′.

All algebraic expressions which have reference to the ellipse become applicable to the hyperbola by changing b^2 into $-b^2$. Thus, referred to the centre as origin, the equation of the hyperbola is

$$\frac{x^2}{a} - \frac{y^2}{b^2} = 1,$$

where $2a$ is the major, and $2b$ the conjugate axis; the equations of the asymptotes are

$$\frac{x}{a} - \frac{y}{b} = 0 \quad \text{and} \quad \frac{x}{a} + \frac{y}{b} = 0.$$

Referred to a vertex A, the equation of the curve assumes the form

$$y^2 = p\,x + \frac{b^2}{a^2}x^2,$$

where p is the *parameter* (*latus rectum*) or double ordinate PP′ through a focus F. The hyperbola derives its name from the property, expressed by this equation, that the square on any ordinate HD exceeds, or differs in *excess* from the rectangle under the corresponding abscissa AH and parameter PP′. The equation of the hyperbola referred to its asymptotes assumes the simple form $4\,x\,y = a^2 + b^2$, whence we learn that the area of the parallelogram formed by the coordinates is constant. When the asymptotes are perpendicular to each other, the hyperbola is said to be *equilateral*, its two axes being also equal. Curves represented by equations of the form

$$x^m\ y^n = \text{a constant}$$

are sometimes termed hyperbolas of higher order; they possess many curious properties.

Hyperbole (Gr. ὑπερβολή, *excess*). In Rhetoric, a figure by which expressions are used signifying more than it is intended to represent to the hearer or reader; as when thoughts and sentiments are clothed in tumid language, or ideas are brought forward which in themselves are incredible, in order to induce a belief of something less than that which is offered. Exaggeration is hyperbole applied to narrative, when false assertions are added to true in order to increase the impression made by them.

Hyperbolic Cylinder. A surface generated by the motion of a line which constantly remains parallel to itself and has a hyperbola

for its director. All its plane sections are hyperbolas.

Hyperbolic Logarithms. A system of logarithms; so called because the numbers express the areas between the asymptote and curve of the hyperbola, those areas being limited by ordinates parallel to the other asymptote, and the ordinates decreasing in geometrical progression. But as such areas may be made to denote any system of logarithms whatever, the denomination is not correct. In place of hyperbolic logarithm, the term *Napierian* logarithm (from the inventor of the logarithms, Baron Napier) is more frequently used by Continental writers, and *natural* logarithm by English ones. [LOGARITHM.]

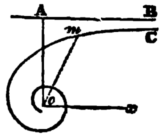
Hyperbolic Paraboloid. A ruled surface of the second order, whose plane sections are either hyperbolas or parabolas. For the method of generating such a surface, see QUADRIC. The equation of the surface may be reduced to the form $z=\frac{x^2}{a}-\frac{y^2}{b}$, whence it is obvious that the plane of the axes x and y meets the surface in the two lines

$$x\sqrt{b}\pm y\sqrt{a}=0;$$

all sections parallel to this plane are hyperbolas, the transverse axes of which are parallel to the x or y axis, according as the section is made above or below the plane $(x\,y)$. All sections through the z axis are parabolas, the convexities of which are turned upwards or downwards, according as the plane cuts through one or the other of the adjacent angles contained by the planes $x\sqrt{b}\pm y\sqrt{a}=0$. A rough illustration is presented by the surface of a saddle. When $a=b$ the paraboloid is said to be *equilateral*; its equation, to other rectangular axes, may be written in the form $xy=az$. The axes of x and y are now lines on the surface, and the coordinate planes, perpendicular to them, meet the surface again in two infinitely distant lines; in other words, they are the *asymptotic planes*. The equilateral paraboloid may obviously be generated by a line sliding along and turning around a directrix to which it always remains perpendicular; it is therefore a *conoidal* surface. [CONOID.]

Hyperbolic Point. A point on a surface, at which the indicatrix is a hyperbola. Such a point is a double point on the section of the surface made by the tangent plane. The two real tangents to the section at this double point are the inflexional tangents at the hyperbolic point. [INDICATRIX.]

Hyperbolic or Reciprocal Spiral. The inverse of the spiral of Archimedes. Its equation is $r=\frac{a}{\theta}$, and consequently it belongs to the family represented by the general equation $r=a\,\theta^n$. [SPIRAL OF ARCHIMEDES.] The hyperbolic spiral was first proposed by James Bernoulli; it has a rectilinear asymptote A B from the infinitely distant point of which it may be said to start, and to arrive at the pole after an infinite number of convolutions. The polar subtangent of this spiral is constant. o



The hyperbolic spiral is also the reciprocal of the INVOLUTE OF THE CIRCLE. The properties of this and of allied spirals are given in most works on Algebraic Geometry.

Hyperboloid. A surface of the second order, which is cut by certain planes in hyperbolas. [QUADRIC.] Two kinds of hyperboloids are distinguished. The one, whose equation is

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}-\frac{z^2}{c^2}=1,$$

is called the *hyperboloid of one sheet*; the other, represented by the equation

$$\frac{x^2}{a^2}-\frac{y^2-z^2}{b^2\quad c^2}=1,$$

bears the name of *hyperboloid of two sheets*, from the fact that certain planes in space do not intersect the surface. In the first the plane sections parallel to the axes a, c, as well as those parallel to b, c, are hyperbolas; whilst those parallel to $a\,b$ are ellipses. In the hyperboloid of two sheets, planes parallel to $a\,b$ and $a\,c$ give hyperbolic sections, whilst those parallel to $b\,c$ are either *real* or *imaginary* ellipses. The hyperboloid of one sheet is a *ruled surface*, that is to say, at every point of it a straight-edge may be applied to the surface in two distinct directions [QUADRIC]; the hyperboloid of two sheets possesses no such property. Replacing 1 by 0 on the left of the above equations, they represent the asymptotic cones of the respective hyperboloids. The distinction between the two hyperboloids is clearest in the case of *hyperboloids of revolution*; when $a=b$ in the first, or when $b=c$ in the second equation.

Hyperboloid of Revolution. A surface generated by the rotation of a hyperbola about one of its axes. If the axes of rotation coincide with the *conjugate axis* of the hyperbola, the generated surface is a *hyperboloid of one sheet*, whilst a *hyperboloid of two sheets* is generated by the rotation of a hyperbola about its *transverse axis*. [HYPERBOLOID.] All hyperboloids of one sheet being ruled surfaces [QUADRIC], those of revolution may be generated by the rotation of a line about any axis not in the same plane with itself. A rough illustration of such a surface is obtained by applying torsion to a bundle of needles held together, in the centre, by a string.

Hyperboreans (Gr. οἱ Ὑπερβόρεοι). Literally, people living beyond Boreas or the north wind, i.e. in the extreme north. In the mind of Herodotus (iv. 32) a vague feeling survived that this people, leading a life of unbroken happiness, in regions beyond the frost and snow, was an actual nation, of whose exist-

ence he needed only better evidence than that which he possessed. In the mythology of Pindar (*Pyth.* x. 55), they are a happy race, into whose home strife and sorrow, war and sickness, cannot enter, where Apollo and the Muses wake undying harmonies, and where the heads of all glisten with wreaths of golden laurel. The myth is connected with that of Perseus, the destroyer, who comes to their glorious garden after having slain Medusa, and flying from her Gorgon sisters, who only just fail to seize him, as he eludes their grasp. This chase, in mythical speech, denoted the pursuit of the sun by the dark shadows of the deathlike night, which he has slain; while his escape signifies the rising of the sun into the upper regions of the sky, where the morning weaves her fairy network of delicate cirrhi clouds. Thus the Hyperborean gardens resolve themselves into the mysterious web of Penelope (the weaver), undone each day, and reproduced on the rising or setting of the sun. Hence, with singular fidelity to the original mythical phrase, Penelope, in the *Odyssey*, says that she will know whether Odysseus is her husband, by his recognition of the woven-work which he wrought for her in the days of their early love (i. e. in the morning). It may be noticed that the Hyperboreans of Pindar wear wreaths of Daphnê (laurel); and thus the myth is connected with the beautiful legend of Daphnê, or Dahanâ, the Dawn, who vanishes away when pursued by her lover, Phœbus, the Sun.

For later speculations and dreams arising out of the myth of the Hyperboreans, see Sir G. C. Lewis, *Astronomy of the Ancients*, p. 490 &c.

Hypercatalectic (Gr. ὑπέρ, *above*, and καταληκτικός, *deficient*). In Greek and Latin poetry, a verse exceeding its proper length by one syllable.

Hypercatharsis (Gr. ὑπέρ, and κάθαρσις, *cleansing*). Excessive purging.

Hypercriticism (Gr. ὑπέρ, and κριτικός, *critical*). Consists in viewing the works of an author in an ungenerous spirit, exaggerating minor defects, and overlooking or undervaluing such merits or beauties as might fairly be considered to outweigh the former.

Hyperdeterminants. The name first given, by their discoverer, Prof. Cayley (*Cambridge and Dublin Math. Journal*, vol. i., and Crelle's *Journal*, vol. xxx.), to the derivative functions, now always referred to as *invariants*. [INVARIANTS.] The terms *hyperdeterminant calculus* and *hyperdeterminant notation*, however, are still in use. The latter consists of such symbols as $\overline{12}$, $\overline{123}$ &c. . . which are respectively abbreviations of the operative symbols

$$\begin{vmatrix} \frac{d}{dx_1}, & \frac{d}{dy_1} \\ \frac{d}{dx_2}, & \frac{d}{dy_2} \end{vmatrix}, \quad \begin{vmatrix} \frac{d}{dx_1}, & \frac{d}{dy_1}, & \frac{d}{dz_1} \\ \frac{d}{dx_2}, & \frac{d}{dy_2}, & \frac{d}{dz_2} \\ \frac{d}{dx_3}, & \frac{d}{dy_3}, & \frac{d}{dz_3} \end{vmatrix}, \quad \&c.$$

The calculus in question consists in operating with such symbols upon the product U V W &c. of given quantics U, V, W, &c., respectively functions of the cogredient variables x_1, y_1 &c.; x_2, y_2 &c.; x_3, y_3 &c.; and the results of such operations are always either covariants or invariants of the system. Thus, if we operate upon the product UV, where

$$U = ax_1^2 + 2bx_1y_1 + cy_1^2,$$
$$V = a'x_2^2 + 2b'x_2y_2 + c'y_2^2,$$

with the symbol $\overline{12}^2$, or written in full,

$$\frac{d^2}{dx_1^2} \cdot \frac{d^2}{dy_2^2} - 2\frac{d^2}{dx_1dy_1} \cdot \frac{d^2}{dx_2dy_2} + \frac{d^2}{dx_2^2} \cdot \frac{d^2}{dy_2^2},$$

we obtain the invariant $ac' - 2bb' + ca'$. Or more generally, if we operate with this symbol upon the product of any two quantics, U and V, whatever, we shall have a covariant in two sets of variables, or simply a covariant of the quantics U and V, if, after differentiation, all suffixes are suppressed. Thus

$$\frac{d^2U}{dx^2} \cdot \frac{d^2V}{dy^2} - 2\frac{d^2U}{dx\,dy} \cdot \frac{d^2V}{dx\,dy} + \frac{d^2U}{dy^2} \cdot \frac{d^2V}{dx^2}$$

is always either a covariant or invariant of the system U, V, and hence also when U and V are identical

$$\frac{d^2U}{dx^2} \cdot \frac{d^2U}{dy^2} - \left(\frac{d^2U}{dx\,dy}\right)^2$$

is a covariant (the Hessian) of the quantic U. Further details, and useful exercises in the hyperdeterminant calculus, are given in Salmon's *Higher Algebra.*

Hyperelliptic Integral. The integral of an expression, which involves the square root of a rational and integral algebraical function of an order higher than the fourth. [ELLIPTIC INTEGRAL.] Such integrals are also called *ultra-elliptic.*

Hypergeometric Series. A series which transcends a geometric one. The ordinary form of such a series is

$$1 + \frac{\alpha.\beta}{1.\gamma}x + \frac{\alpha(\alpha+1).\beta(\beta+1)}{1.2.\gamma(\gamma+1)}x^2 + \&c.$$

for which Gauss uses the symbol $F(\alpha, \beta, \gamma, x)$, and Cayley has proposed the modification

$$F\begin{pmatrix}\alpha, \beta \\ 1, \gamma\end{pmatrix}; x\Big)$$

in order to extend the same notation to ultra-hypergeometric series, such as

$$F\begin{pmatrix}\alpha, \beta, \gamma \ldots \\ 1, \delta, \epsilon \ldots\end{pmatrix}; x\Big).$$

If we put

$$y = \int_0^1 u^{\beta-1}(1-u)^{\gamma-\beta-1}(1-xu)^{-\alpha}\,du,$$

it will be found that

$$F\begin{pmatrix}\alpha\ \beta \\ 1, \gamma\end{pmatrix}; x\Big) = \frac{y}{B(\beta, \gamma-\beta)};$$

where B denotes a *Eulerian integral*, whilst y

satisfies the linear partial differential equation of the second order

$$x(1-x)\frac{d^2y}{dx^2} + [\gamma-(\alpha+\beta+1)x]\frac{dy}{dx}-\alpha\beta\gamma=0.$$

(Euler's *Institutiones Cal. Integ.* vol. ii.) Investigations on Hypergeometric Series will be found in Gauss' and Jacobi's collected works; a valuable memoir on the subject by Kummer was published in Crelle's *Journal*, vol. xv. 1836.

Hypericaceæ (Hypericum, one of the genera). A natural order of Exogenous plants belonging to the Guttiferal alliance. They usually have yellow flowers with the petals wider on one side than the other, and marked with black dots; while the leaves are in many cases marked with transparent dots. They are usually strong-scented and astringent. Some of them have coppery red flowers, and yield a resinous substance resembling gamboge.

Hypericum (Gr. ὑπέρεικον, or ὑπέρικον, from ἐρείκη, *heath*). The *Hypericum perforatum*, or St. John's Wort, was much esteemed by the ancients as an anodyne.

Hyperion (Gr. Ὑπερίων). In the *Theogony* of Hesiod, Hyperion, or the lofty one, is a son of Uranus (Heaven) and Gæa (Earth), and the father, by his sister Theia, of Helios (the Sun), Selênê (the Moon) and Eos (the Morning). But in the Homeric poems the word is a mere synonym for Helios, and the two names more commonly occur together. From the length of the penultimate syllable, the word is generally regarded as a contraction of Hyperionion, and equivalent to the patronymic form Hyperionides. [TITAN.]

HYPERION. In Astronomy, one of the satellites of Saturn.

Hyperoxymuriates. Combinations of chloric acid were formerly so called: thus, chlorate of potash was called hyperoxymuriate of potash.

Hypersthene (Gr. ὑπέρ, and σθένος, *strength*). Labrador Hornblende. It is a ferrosilicate of magnesia, with traces of alumina and of lime. It occurs crystalline and massive; it is resplendent, and of a grey-green or reddish hue.

Hyperthyrum (Gr. ὑπέρθυρον, from θύρα, *a door*). In Architecture, the lintel of a doorway.

Hypertrophy (Gr. ὑπέρ, and τροφή, *food*). A term frequently applied to the morbid enlargement of any part of the body This term ought to be restricted to cases in which a part, though increased in bulk, retains its natural organisation and structure.

Hypha. In describing *Algæ*, denotes the filamentous, fleshy, watery thallus of *Bussaceæ*.

Hyphæne (Gr. ὑφαίνω, *to weave*). The Doum Palm of Egypt, one of the few plants in this noble family which produce branching trunks, belongs to this genus. It is called *H. thebaica*, and sometimes the Gingerbread-tree, the fibrous mealy husk of the fruit, which is eaten by the poorer classes, tasting like gingerbread. This or some allied species is widely dispersed over tropical Africa.

Hyphen (Gr. ὑφέν, strictly ὑφ' ἕν, *in one*). In Printing and Writing, a mark or character thus (-), implying that two or more words are connected, as mother-in-law, self-love. In printed books, when a word is divided, the hyphen goes with the part of the word at the end of the first line, never at the beginning of the second.

Hypnotics (Gr. ὑπνωτικός, *drowsy*). Medicines which induce sleep.

Hypo (Gr. ὑπό, *under*). In Chemical nomenclature, this prefix indicates the presence of a smaller quantity of oxygen than that contained in the acid or compound to which it is prefixed; thus the *hyposulphurous acid* contains less oxygen than the sulphurous, and the *hyposulphuric acid* less oxygen than the sulphuric; and the *hyponitrous* acid less oxygen than the nitrous, &c.

Hypoaria (ὑπό, *under*). Oval ganglionic structures into which the fibres of the prepyramidal tracts of the brain in fishes swell out beneath the optic lobes. Their bulk is increased by added grey matter, variegating their outer surface. In the cod and in some other fishes, they contain a cavity called *hypoarian ventricle*.

Hypocaustum (Gr. ὑπόκαυστον, from ὑπό, and καίω, *I burn*). In Ancient Architecture, a vaulted apartment from which heat was distributed to the rooms above by means of earthen tubes.

Hypochloric Acid or **Peroxide of Chlorine.** A green gas evolved when chlorate of potash is acted on by sulphuric acid. It contains one equivalent of chlorine and four of oxygen, and explodes when heated to 212°

Hypochlorous Acid. A yellow unstable gas containing one equivalent of chlorine and one of oxygen. Formed when chlorine is agitated with moist mercuric oxide. It is supposed to be the bleaching agent in the so-called chloride of lime.

Hypochondriasis (Gr. ὑπό, *under*, and χόνδρος, *cartilage*). Uneasiness about the region of the stomach and liver, or of the *hypochondriac region*, is one of the symptoms of this disease. Particular circumstances may induce this disorder in any individual; but it is most commonly met with in persons of sallow or pale complexions, spare habit of body, and dark hair and eyes. Its mental symptoms are low spirits, a groundless apprehension of evil, imaginary local sensations, and erroneous impressions respecting the opinions and sentiments of others, with a tendency to misconstrue their actions; aversion to society; want of mental and bodily energy; seeing persons and things and hearing conversations and noises which are purely imaginary. The bodily symptoms are flatulency and all the other concomitants of indigestion—costiveness, dimness of sight, noises in the ears, want of appetite and sleep in most cases, in few voracity and drowsiness. As this disease is usually connected with imperfect action of the liver, mild aperients, small doses of calomel or blue

pill, and tonics are to be prescribed; but occasionally more powerful purgatives must be resorted to; and where there is much headache, a blister to the neck, or the loss of a *little* blood by cupping, or from the arm, may be of service. The regularity of the circulation is often much disturbed, and it is generally necessary to keep the feet warm.

Change of scene and of occupation, cheerful society, moderate exercise of all kinds, and great kindness and attention on the part of the medical adviser, are generally among the essentials in the treatment of this diseased state. But every amusement and relaxation must be carefully proposed and pursued; and though it is generally necessary firmly but gently to remonstrate against the whims and caprices of hypochondriacs, yet sometimes they must be conceded to. When persons are full of evil forebodings and false alarms, it is sometimes well to induce them to keep a diary of their feelings, the perusal of which as they recover, or in their happier moments, is often comforting proof to them of the utter want of foundation of some of their most inveterate notions. Persons who are very irritable and over-anxious, or who, after having been actively engaged in business, retire to a life of ease and idleness, who take no interest in study, amusement, or exercise; and those, again, who have kept bad hours, or who have led debauched lives, or who have studied intensely—are those in whom some of the worst forms of hypochondriasis occur. It is seldom in the most aggravated cases of this disorder that well-grounded hopes of recovery may not be held out, and that its recurrence may not be prevented by timely and firm treatment; but if it be allowed to run its course, it often ends in melancholy.

Hypocrateriform (Gr. ὑπό, and κρατήρ, *a cup*). In Botany, that form of a corolla which consists in a cylindrical tube which is longer than the flat-spreading limb, as in the flowers of the genus *Phlox*. It is called in English *salver-shaped*.

Hypocycloid (Gr. ὑπό, and κυκλοειδής, *circular*). The curve traced by a point in the circumference of a circle which rolls on the concave side of a fixed circle. When the radius of the rolling circle exceeds that of the fixed circle, the hypocycloid may always be generated as an epicycloid. [Epicycloid.] This property was discovered by Euler (*Acta Retrop.* 1784). When the radius a of the fixed circle is double that of the rolling one, the hypocycloid coincides with the diameter of the fixed circle. When the radius a of the fixed circle is four times that of the rolling circle, the hypocycloid is also algebraic, and has for its equation

$$x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}.$$

Hypocyst. A Pharmaceutical name of the inspissated juice of the *Cytisus hypocistis*, a parasitical plant on the roots of several species of *cystus* in the South of Europe.

Hypogæous (Gr. ὑπό, and γῆ, *the earth*). Literally, *subterranean*. In Botany, it denotes all parts in plants which grow beneath the surface of the earth.

Hypogastrium (Gr. ὑπό, and γαστήρ, *the stomach*). The middle part of the lower region of the belly.

Hypogene (Gr. ὑπό, and γίνομαι). A name given by Sir Charles Lyell to a group of rocks formed within the earth, modified probably from regular stratified aqueous rocks, but having lost all their original characteristics before they are presented to us for examination. Granite, porphyries, metamorphic limestone and quartzite, are all of them generally to be regarded as hypogene rocks. They are especially abundant in mountain districts, forming either the highest and geographical axis or the real geological axis of every principal chain.

Hypoglossal Nerves (Gr. ὑπό, and γλῶσσα, *the tongue*). The lingual nerves.

Hypogynous (Gr. ὑπό, and γυνή, *a female*). In Botany, a term denoting anything growing from below the base of the ovary.

Hypomochlion (Gr. ὑπομόχλιον, from μοχλός, *a lever*). In Mechanics, the fulcrum or support of a lever, or the point against which the pressure is exerted. This term is met with only in the old treatises on mechanics; the equivalent term *fulcrum* being now generally used.

Hyponitric Acid. A compound of one atom of nitrogen with four of oxygen. It has really no acid properties, and hence is now generally termed *peroxide of nitrogen.* It is formed on mixing binoxide of nitrogen with half its volume of oxygen, or by heating nitrate of lead. It may be liquefied, and even solidified, by cooling.

Hyponitrous Acid. An acid intermediate between nitric oxide and nitrous acid, composed of 1 equivalent of nitrogen = 14, and 3 of oxygen = 24, the equivalent of the hyponitrous acid, upon the hydrogen scale, being = 38.

Hypophosphorous Acid. An acid composed of 1 atom of phosphorus and 1 of oxygen, or 32 phosphorus + 8 oxygen.

Hypophyllium (Gr. ὑπό, and φύλλον, *a leaf*). In Botany, a term invented to denote a petiole that has the form of a small sheath, is destitute of lamina, and surrounds the base of certain small branches, having the appearance of leaves; as in asparagus. It is nothing but a rudimentary leaf.

Hypophyllous. In Botany, applied to bodies which grow on the underside of a leaf.

Hypopium (a term coined from Gr. ὑπό, and πῦον, *pus*). A disease of the eye, in which there is an apparent collection of pus under the transparent cornea; that is, in the chamber of the aqueous humour.

Hyposcenium (Gr. ὑποσκήνιον, from ὑπό, and σκηνή, *a scene*). In ancient Architecture, the front wall of a theatre, facing the orchestra, from the stage.

Hypostasis (Gr. ὑπόστασις, answering to the Latin substantia). A term used by the Greek fathers to express the distinct *personality* of the Father, Son, and Holy Ghost. This term is retained by the Latin fathers,

who, like ourselves, had no word which could exactly represent hypostasis, which differs from *οὐσία*, *substance*, inasmuch as the latter is used for the divine substance, essence, or being—that which is common to each of the hypostases, persons, or individual substances which compose the one Godhead.

Hypostatic Union. A term used to signify the union of Christ's human nature with the divine, constituting two natures in one person.

Hyposulphuric Acid. An acid intermediate between the sulphurous and sulphuric acids. It may be regarded as containing 2 atoms of sulphur ($16 \times 2 = 32$), and *5* of oxygen ($8 \times 5 = 40$); or as constituted of 1 atom of sulphurous acid = 32, and 1 of sulphuric acid = 40. In either case its equivalent is 72.

Hyposulphurous Acid. An acid constituted of 2 atoms of sulphur ($16 \times 2 = 32$) and 2 of oxygen ($8 \times 2 = 16$). It is necessary to take this view of composition, its equivalent number being 48.

Hypothecation (Gr. ὑποθήκη, *a pledge*). In the Civil Law, an engagement by which the debtor assigns his goods in pledge to a creditor as a security for his debt, without parting with the immediate possession; differing, in this last particular, from the simple pledge. The term *hypothecation* is usually applied to things immovable only (i. e. according to the division of the English law, to things real, things personal savouring of the realty, and choses in action), and not to things movable (i. e. things personal in possession). It answers in general to the English mortgage. [MORTGAGE.]

Hypothenuse (Gr. ἡ ὑποτείνουσα γραμμή, *the subtending line*). In Geometry, the side opposite the right angle of a right-angled triangle.

Hypothesis (Gr. ὑπόθεσις). In a mathematical proposition, this term denotes that which is assumed or granted, and from which the assertion or predicate follows as a consequence. The converse of a proposition is formed by making the predicate hypothesis and the hypothesis predicate. As an example, we have the 47th and 48th propositions of the first book of Euclid. According to the first, if a triangle is right-angled, the square on one side is equal to the sum of the squares on the other two; according to the second, if the sum of the squares on two sides of a triangle is equal to the square on the third side, the triangle is right-angled.

HYPOTHESIS. In Physics and Natural Science, this term denotes a gratuitous supposition to account for some phenomenon or appearance of the natural world. If the hypothesis serves to explain a great number of the circumstances accompanying a phenomenon, it acquires a certain degree of probability; and if all the known circumstances can be deduced from it, the probability becomes very great (it then usually acquires the name of a *theory*), and in the lapse of time may amount to certainty. Thus the hypothesis of the diurnal rotation of the earth and its translation in the ecliptic, imagined by Copernicus to explain the planetary phenomena, has acquired all the characters of certainty from continual astronomical observation. In like manner, Kepler's hypothesis, that the planets move in elliptic orbits, has been so fully confirmed by subsequent discoveries and computations, that, however doubtful it might be at first, no one who is capable of understanding the evidence can hesitate to receive it as an established law of nature. 'A well-imagined hypothesis,' says Sir John Herschel, 'if it have been suggested by a fair inductive consideration of general laws, can hardly fail at least of enabling us to generalise a step further and group together several such laws under a more universal expression. But this is taking a very limited view of the value and importance of hypotheses. It may happen (and it has happened in the case of the undulatory theory of light) that such a weight of analogy and probability may be accumulated on the side of an hypothesis, that we are compelled to admit one of two things—either that it is an actual statement of what really passes in nature; or that the reality, whatever it be, must run so close a parallel with it as to admit some mode of expression common to both, at least in so far as the phenomena actually known are concerned. Now, this is a very great step, not only for its own sake, as leading us to a high point in mathematical speculation, but for its applications, because whatever conclusions we deduce from an hypothesis so supported must have at least a strong presumption in their favour; and we may be thus led to the trial of many curious experiments, and to the imagining of many useful and important contrivances, which we would never otherwise have thought of, and which, at all events, if verified in practice, are real additions to our stock of knowledge and to the arts of life.' (*Discourse on the Study of Natural Philosophy.*)

Hypotrachelium (Gr. ὑποτραχήλιον, from τράχηλος, *the neck*). In Architecture, the slenderest part of the shaft of a column, being that immediately below the neck of the capital.

Hypotrochoid (Gr. ὑπό, and τροχοειδής, *like a wheel*). The curve traced by a point which is fixed relative to a circle rolling on the concave side of a fixed circle. Hypotrochoids bear the same relation to hypocycloids as epitrochoids do to epicycloids. All belong to the family of roulettes, and the hypotrochoid becomes a hypocycloid when the generating point is on the circumference of the rolling circle. The hypotrochoid is an algebraical curve when the circumferences of the two circles are commensurable; in other cases it is transcendental. The most interesting case is when the radius of the fixed circle is double that of the rolling one; the hypotrochoid is then an ellipse, a fact of which advantage is taken in the construction of so-called elliptic compasses. [ELLIPSE.]

Hypotyposis (Gr. ὑποτύπωσις, from τύπος, *a type*). In Rhetoric, an animated representation of a scene or event in descriptive language highly enriched with rhetorical figures.

Hypoxidaceæ (Hypoxis, one of the genera). A natural order of epigynous monocotyledons.

belonging to the Narcissal alliance. They are known by their hexapetaloid flowers, by their six stamens with introrse anthers, and by having the radicle remote from the hilum in their seed. They are not of much importance.

Hypsiprymnus (Gr. ὑψίπρυμνος, *with high stern*). A genus of Poëphagous marsupials, of which the Kangaroo Rat (*Hypsiprymnus murinus*) is found in New South Wales. The upper middle incisors are long and produced beyond the small lateral ones. The posterior far surpass the anterior extremities in length. The tail is shorter than the body, and slender.

Hypsometry (Gr. ὕψος, *height*, and μέτρον, *measure*). The art of measuring height, either relative or absolute, by trigonometry or the barometer.

Hyraceum. An article imported, as a substitute for castor, from the Cape of Good Hope, and derived from one of the species of *Hyrax*.

Hyracotherium (Gr. ὕραξ, and θηρίον, *beast*). A genus of diminutive Perissodactyle mammalia, which flourished in England during the middle eocene period. It exhibited the typical dentition (44 teeth). Its nearest affinities were with *Pliolophus* and *Stereognathus*.

Hyrax (Gr. ὕραξ, *a shrew-mouse*). This term is now applied to a genus of small Mammalia which rank next the rhinoceros in the order of their affinities, and are the most diminutive representatives of the Pachydermatous order. The two known species are found in hilly districts at the Cape (*Hyrax capensis*), and in Syria (*Hyrax syriacus*): the latter species is the *cony* of Scripture.

Hyson. A commercial name of one of the varieties of *green tea.* [TEA.]

Hyssopus (Lat.; Gr. ὕσσωπος; Heb. ézôb). A genus of *Labiatæ*. *H. officinalis*, the Common Hyssop, is one of the bitter aromatic herbs which were formerly used as a stimulating stomachic, but it is now seldom employed.

Hysteranthius (Gr. ὕστερος, *after*, and ἄνθος, *a flower*). In Botany, a term denoting the appearance of the leaves after the flowers; as in the almond.

Hysteria (Gr. ὑστέρα, *the womb*, with which the disease was supposed to be generally connected). Hysteria generally attacks unmarried females between the ages of fifteen and thirty-five, coming on with low spirits and anxiety, sickness, short breath, and palpitation, sobbing, and a sense of distension of the bowels, which afterwards seems to concentrate itself in the stomach, and then rise like a ball into the throat (*globus hystericus*), where it produces gasping, stupor, convulsive motions, crying, laughing, hiccough, flow of saliva from the mouth, and delirium: at length the spasms abate, and the person gradually recovers, generally with the expulsion of wind from the stomach. Some of these symptoms are often much more prevalent than others, so that the disorder assumes many forms: it is also very variable in its duration, lasting from an hour or two to one or two days. The treatment varies extremely with the apparent causes of the disorder; sometimes bleeding and depletives, at others stimulants and tonics are required; in mild cases sprinkling with water and applying nasal stimulants give relief. Great attention to the exciting cause, exercise, moderate and judicious amusements and occupations, regular hours, and change of air and scene, are among the best preventives of its recurrence.

Hysteritis. Inflammation of the womb. This dangerous disease generally occurs the second or third day after delivery; it is attended by fever and pain of the part, and requires active antiphlogistic treatment.

Hysterology or **Hysteron Proteron** (Gr. ὕστερος, *the latter of two*, and λόγος). In Rhetoric, a figure by which the ordinary course of thought is inverted in expression, and the last put first; as, where objects subsequent in order of time are presented before their antecedents, cause before effect, &c. Some comprehend the figure usually called *anticlimax* [CLIMAX] under the name Hysterology.

Hysterotomy (Gr. ὑστέρα, *the womb*; τέμνειν, *to cut*). The extraction of the fœtus from the uterus. The *Cæsarean operation*.

Hystricidæ (Gr. ὕστριξ, *a porcupine*). The name of the family of Rodent Quadrupeds, of which the porcupine (*Hystrix cristata*) is the type.

I

I. The ninth letter of the English and most European alphabets, represents two very different sounds in different languages. In the Greek language, the letter *i* is the simplest of the alphabetical characters, being represented by a single stroke, thus, ι. It is also susceptible of various interchanges, more particularly in the Latin, Greek, and French languages. When two *i*'s followed in succession, the Romans used to contract them into a single long *i*, as *Di* for *Dii*, *tibicen* for *tibiicen*; or made the letter larger than usual, as *Chlus*. Shakspeare sometimes substitutes *I* for *ay* or *yes*.

> Did your letters pierce the queen?
> *I*, sir; she took 'em and read 'em in my presence.

According to Gebelin, the letter *i* in hieroglyphic writing represents the human hand. As a Roman numeral it denotes 1; and if placed before V or X, it diminishes by a unit the number expressed by these two letters. The form of J was originally identical with that of I; and it is only within the last century that

any distinction was made between them. In the English and French languages J has a sibilant sound, but the Germans pronounce it exactly as the English *y* before a vowel. In the Spanish language J represents a guttural, and is frequently substituted for X. which has the same sound.

I. H. S. This abbreviation is generally supposed to represent the initial letters of the words *Jesus Hominum Salvator*. More probably they are the first three letters of the Greek name ΙΗΣΟΥΣ, *Jesus*.

Iacchus. [Bacchus; Dionysus.]

Iambics (Gr. ἴαμβος). A species of verse used by the Greek and Latin poets, and especially by the Greek tragic poets. The derivation of the word has not been ascertained. The iambics of the Greek tragic poets consisted of three entire metres or six feet, and were thence styled the tragic *trimeter acatalectic*. They were composed originally, as their name implies, of a succession of iambi (⏑–) [Foot, in Prosody]; but at a later period, various other feet were admitted, of which the subjoined table will convey an idea:—

1.	2.	3.	4.	5.	6.
⏑–	⏑–	⏑–	⏑–	⏑–	⏑–
⏑⏑⏑	⏑⏑⏑	⏑⏑⏑	⏑⏑⏑	⏑⏑⏑	
––		––		––	
–⏑⏑		–⏑⏑			
⏑⏑–					

Hence it will be seen that a tribrach may be introduced into all the places except the last; a spondee in the first, third, and fifth places; a dactyl in the first and third places; and an anapæst in the first. This foot may also be used in all other places of the verse except the last; with the general restriction, that in the third and fifth places it should be contained in a proper name, as Antĭgŏnē, or in a preposition and the word which it governs; but two feet containing three syllables may not follow each other. The comic writers used much greater license in the iambic trimeter, admitting an anapæst, even in common words, into every place but the last. For a full exposition of this and the other iambic metres employed by the Greek and Latin poets, the reader may consult Hermann's *Elementa Doctrinæ Metricæ*; Porson's editions of the *Tragedies of Euripides*; and the article 'Iambic Verse' in Rees's *Cyclopædia*. In most modern European languages, the verse of five iambic feet is a favourite metre. In French it is used almost entirely in lighter poetry, as by La Fontaine and similar writers, the heroic verse being the sixth foot, or alexandrine; but in English, German, and Italian, the former is the verse of ordinary use in serious composition. The Italians divide it into—1. The *verso cadente*, in which the line is decasyllabic, consisting of five iambi: e.g.

E come albero in nave si levò.—Dante.

This variety is very rarely admitted in serious composition, and is ill suited to the character of the language. Poets have, however, sometimes sportively attempted whole series of versi cadenti; as in the set of sonnets of Casti, called *I tre Giuli*. 2. The verso eroico, or hendecasyllabic, which is the ordinary one, ending in a short syllable:

Canto l'armi pietose, e 'l capitānŏ.

3. The verso sdrucciolo, which ends with two short syllables after the fifth iamb:

Passi oziosa, e di tua gloria immēmŏrĕ.

This also is rarely used in serious writing; but its occasional employment adds a peculiar grace to lighter poetry. In English, according to the genius of the language, the decasyllabic line is most common; the hendecasyllabic occasional, and more frequent in blank verse than in rhymes, in consequence of the comparative rarity of trochaic rhymes. The German language is rich both in iambic and trochaic terminations: consequently the decasyllabic and hendecasyllabic are more indiscriminately employed than in either English or Italian; and it is not uncommon to use the elegant variety of alternate iambic and trochaic rhymes, like the French masculine and feminine.

Iapetus (Gr. Ἰαπετός). In Astronomy, one of the satellites of Saturn [which see].

Iapetus. In Greek Mythology, a Titan, brother of Cronos and Hyperion, and father of Prometheus.

Iatraleiptes (Gr. ἰατραλείπτης, from ἰατρός, *a physician*, and ἀλείφω, *I anoint*). A physician who cured diseases by external remedies only, as by friction, inunction, &c. There was among the Greeks a sect of Iatraleiptæ founded by Prodicus.

Iatromathematici (Gr. ἰατρομαθηματικοί). Physicians who explain the functions of the body, and the action of remedies, on mechanical principles. These doctrines seem to have originated with Asclepiades, and in modern times were promulgated by Borelli as founded on the atomic philosophy of Descartes.

Ibex (Lat.). This name is restricted to a species of goat; the *Capra Ibex* of Linnæus, *Bouquetin* of Buffon and the French naturalists. It is characterised by having large horns, with a flattened anterior surface, and marked with prominent transverse ridges or knots. It inhabits the summits of the highest mountain chains in the continents of Europe, Africa, and Asia, but does not exist in the New World.

Ibis. A species of birds, belonging chiefly to the old genera *Scolopax* and *Tringa* of Linnæus. The green ibis, *I. falcinelus*, is found in the warmer zones of all quarters of the world. In the Egyptian ibis, the preva colour is white, with long plumes of a p hue proceeding from the tertiary wing-fe It was one of the sacred animals of the ancient Egyptians, the penalty for slaying which was death. (Herod. ii. 65.)

Icacinaceæ (Icacina, one of the genera). A natural order of hypogynous Exogens, referred by Lindley to the Berberal alliance. They are related to *Olacaceæ*, and differ from that order in the calyx not enlarging with the fruit; in the stamens being alternate with the

petals; in the ovary being normally many-celled with axile placentation, and one-celled only by abortion; and in the ovules being suspended below the summit of the cell. They are not known to be of any special use.

Icarus. In Mythology. [DÆDALUS.]

Ice (Ger. eis). Frozen water. At the temperature of 32°, water, in its ordinary condition, crystallises into ice, which if slowly produced forms prisms crossing each other at angles of 60° and 120°; the primitive figure has not been ascertained, though it is probably rhomboidal. The arrangement of the acicular prisms in flakes of snow is very various, but in the same snow storm the same forms of arrangement generally prevail. The specific gravity of ice in its densest form is about ·950. It is a non-conductor of electricity, and becomes electric by friction. The expansion of water in the act of freezing takes place with irresistible force, and the frequent rupture of thick iron and leaden pipes from this cause is a familiar instance of this. Exposed to air, ice loses considerably by evaporation. In the act of freezing, water parts with all soluble matter, so that coloured water becomes colourless ice; saline solutions become pure water; and spirituous liquors part with their alcohol. To effect this purification perfectly, the ice must be formed under circumstances which prevent the accumulation of blebs and air-bubbles, and the entanglement in the ice of any of the unfrozen or ejected liquor, for the foreign matters held previously in solution in the water are, in the act of freezing, transferred to the portion which remains unfrozen. If the whole of the water becomes a mass of porous ice, the impurities are retained in the pores; but if the freezing takes place slowly and regularly, time is given for the escape of the impurities, and thus the brilliant and perfectly transparent and dense masses of ice which we find in the Norway ice, as imported into this country, yield, when thawed, water almost equal in purity to that which has been distilled, and nearly free from air.

A remarkable property possessed by ice is that of *regelation*, first noticed by Professor Faraday. If two pieces of melting ice be placed together in a warm room, the film of water between them soon freezes and cements the two masses together, and this effect also takes place beneath the surface of warm water. It is thus that the broken masses of ice forming the ice cascade of a glacier, become again a solid and unbroken mass after the cascade is passed. [GLACIER.]

Ice Caves. [GLACIÈRES.]

Ice Islands. [ICEBERG.]

Ice Plant. The garden name of *Mesembryanthemum crystallinum*, whose leaves are covered with crystalline warts which look like fragments of ice.

Ice Spar. A mineralogical synonym for the Glassy Felspar which is found in Vesuvian lavas. The name, which has reference to the resemblance of the mineral to ice, is also applied to pellucid varieties of other kinds of Felspar.

Ice Trade. The progress of civilisation has rendered the means of procuring coolness in summer almost as indispensable as the generation of warmth in winter, and ice is now largely used for keeping small chambers called ice-safes at a low temperature, favourable for the preservation of provisions, whilst no inconsiderable quantity is directly applied to the cooling of wines and other beverages.

Prior to 1844, the consumption and use of foreign ice in England were very insignificant, but in that year the Wenham Lake Ice Company established their business in London, for the supply of pure ice only. This they procured from the Wenham Lake, about eighteen miles from Boston; but in consequence of the high freight, and the great waste attending its importation and storage, the speculation proved a failure. The company then turned their attention to Norway, from which ice of equal thickness and compactness could be obtained at less cost; the only difficulty being that of obtaining it of equal purity. The fjords of Norway yield ice of considerable thickness, in unlimited quantities, and of easy access for shipment; but such ice was found to be too impure for table use. The ice of many of the Scandinavian lakes, although very transparent, also proved, when analysed, very unsuitable, owing to the presence of much organic matter, which rendered it liable to putrefaction after melting. The lake ultimately selected by the company is remarkable for the purity of its water, which is attributable to the fact of its being supplied by springs only, and not by mountain torrents bringing down with them decomposing vegetable matter in large quantity. This lake, from which the company have procured their celebrated ice for many years past, lies a few miles from Dröbak in the Christiania Fjord, and being their property has been named and registered the *Wenham Lake*.

As soon as it became known that ice of great thickness could be obtained cheaply from the fjords and lakes adjoining the coast of Norway, fishermen began to use it in preference to English ice for packing and preserving their fish, thus creating an extensive demand for the inferior kind of block ice, the importation of which during the year 1864 exceeded 30,000 tons, brought chiefly to London, Hull, Grimsby, and Liverpool.

Iceberg (Ger. eis, and berg, *a mountain*). A portion of a glacier broken away from some tract of land and floating in the sea. An iceberg is a true floating island, containing often an enormous quantity of stones, gravel, and mud, slowly accumulated, as the glacier is gradually pushed into the sea, until the smaller specific gravity of ice than water has made the mass in the sea so much lighter than the same volume of sea-water as to overcome the cohesion of the whole and cause a fracture. Masses of ice thus broken and floated off vary very much in dimensions, amounting sometimes to islands

measuring several miles in circumference, very high and of enormous depth.

Icebergs floating away from the land near the Arctic and Antarctic circles are conveyed by marine currents towards the equator, and often pass far into the temperate zone in both the northern and southern hemispheres. They have even been known to cross the Gulf Stream to the Azores, their depth being so much greater than that of the warm water crossing the Atlantic as to reach counter-currents, carrying them at right angles to that stream. From the south pole they have reached the Cape of Good Hope.

So great is the multitude of icebergs, that Dr. Scoresby, when navigating the polar seas in search of whales, counted 500 drifting along in latitudes 69° and 70° N. Some of them rose above the surface to the height of 100 to 200 feet, and measured from a few yards to a mile in circumference. (*Voyage in* 1822, p. 233.) Many were loaded with beds of earth and rocks, of such thickness that the weight was conjectured to be from 50,000 to 100,000 tons; and on closer examination the mass was found to be composed, among other substances, of granite, gneiss, mica-schist, clay-slate, granular felspar, and greenstone. Some idea may be formed of the immense depth to which icebergs descend, from the fact that the mass of ice below the level of the water is about eight times greater than that above. Icebergs differ from ice floes. The former are made up of ice collected in large masses on land and pushed into the sea till their bulk is very considerable. Ice floes are masses made up of flat ice, packed and heaped by driving winds and storms and opposing currents, and frozen together: in this way very large islands of ice accumulate; but they are not deep, and cannot therefore be floated so far, nor are they loaded with mud and stones.

Iceland Moss. The *Cetraria islandica*, a common lichen in the mountainous districts of Europe. It contains a bitter principle, and a considerable quantity of starchy matter; it is tonic and nutritive, and is often prescribed in disorders of debility, and in pulmonary consumption.

Iceland Spar. A transparent rhomboidal variety of Calcspar, or carbonate of lime, found in Iceland. This form of crystallised carbonate of lime is particularly valuable for experiments on the double refraction and polarisation of light. [CALCAREOUS SPAR.]

Ich Dien (Ger. *I serve*). The motto of the prince of Wales, adopted originally by Edward the Black Prince in proof of his subjection to his father Edward III.; it has been continued without interruption down to the present time.

Ichneumon (Gr. ἰχνεύμων, literally *the tracker*). A name applied in Zoology, in a double sense, to a Viverrine genus of quadrupeds, and to a family of Pupivorous Hymenoptera. As regards the Mammalia, the name is changed by Illiger for HERPESTES [which see], and this term has been generally adopted by English zoologists. The ichneumon of the Nile (*Herpestes Pharaonis*) was one of the sacred animals of the ancient Egyptians; and although many fabulous feats were narrated of it as the enemy of the crocodile, there is no doubt but that the instinct which impels it to search for the eggs of the crocodile as an article of food tends materially to diminish the number of that destructive reptile. The ichneumon preys, however, on the eggs and young of various species of animals. Mr. Bennett relates that on one occasion a grey ichneumon (*Herpestes griseus*) killed no fewer than twelve full-grown rats, which were let loose to it in a room sixteen feet square, in less than a minute and a half. [PUPIVORA.]

Ichnography (Gr. ἰχνογραφία, from ἴχνος, *a mark or trace*). In Architecture, the representation of the ground plot of a building. In Perspective, it is the representation of the building, intersected by a horizontal plane at its base or ground floor.

Ichor (Gr. ἰχώρ). A thin watery discharge. By the Greeks this name was applied to the divine fluid that issued from the wounds of the gods.

Ichorology (ἰχώρ, and λόγος). The anatomy of the lymphatic and secreting systems.

Ichthidin. An albuminoid substance contained in the roe of certain fishes.

Ichthyocolla (Gr. ἰχθύς, *a fish*, and κόλλα, *glue*). [ISINGLASS.]

Ichthyodorulites (Gr. ἰχθύς, *fish*; δόρυ, *spear*; and λίθος, *stone*). The petrified spines of placoid fishes, of which they are often the sole evidences, especially in the Upper Silurian and Devonian strata.

Ichthyolite (Gr. ἰχθύς, and λίθος). A name sometimes given to the fossil remains of fishes, without regard to their geological position. *Ichthyolites* have been found in rocks of all ages from the Silurian to the newest tertiary.

Ichthyology (Gr. ἰχθύς, and λόγος). The science which treats of the nature, uses, and classification of fishes.

Fishes are those oviparous vertebrate animals which have a heart consisting of one auricle and one ventricle, which breathe water, and have the nasal cavity communicating with the external surface only. In a few species an air-bladder is present, and so organised as to act the part of a lung; but the principal, if not exclusive, organ of respiration consists, throughout the whole class, of branchiæ or gills. The gills are commonly composed of rows of slender flattened processes suspended by arches, attached in general to the hyoid bone, and covered with a membrane or tissue of innumerable minute and close-set blood-vessels. The water which the fish takes in by the mouth, instead of being swallowed, passes through the interspaces of the gills, and escapes by the fissures on each side of the head, called *gill-apertures*. The air contained in the water acts upon the blood, which is minutely subdivided in the branchial vessels; and the bilocular heart serves exclusively to propel the whole of the venous blood

to the branchial arteries, and is thus analogous in function to the pulmonary auricle and ventricle of the warm-blooded classes. The blood, having been decarbonised in the gills, is collected into the dorsal arterial trunk or aorta, and is propelled, without the influence of a systemic heart, to all parts of the body; whence it is again returned by the veins to the branchial auricle and ventricle.

The whole structure of a fish is as evidently adapted for swimming as that of a bird for flight. Being suspended in a fluid of nearly the same specific gravity as itself, it has no need of widely-expanded wings for its support. Many species, moreover, have the air-bladder so organised and developed as, by its contractions and dilatations, to vary the specific gravity of the fish, and aid in its ascent to the surface, or descent into the depths of the water. Ordinary progression is effected by the motions of the tail, which, by the action of powerful muscles, displaces the water alternately to the right and left; the gills, also, in expelling the water backwards, may contribute, by the reaction of the current, to propel the fish forward. The ordinary extremities, therefore, being of little use, are reduced to a low or rudimental condition; they are chiefly remarkable for the number of parts corresponding to the digital phalanges of the higher classes, and which, from their disposition, are called *rays*. The pieces analogous to the bones of the arms and legs are extremely shortened, and often quite concealed; the membrane supported by the diverging rays rudely represents the hands and feet. The members thus constructed are called *fins*; those which answer to the anterior extremities are called the *pectoral fins*; those which answer to the posterior extremities are the *ventral fins*. Other rays attached to peculiar bones above or between the extremities of the spinous processes support the vertical fins, which are mesial and single, either above the back, beneath the tail, or at the extremity of the tail. The upper vertical fin or fins are called the *dorsal*, the lower ones the *anal*, and the terminal one the *caudal* fin. The fin-rays are of two kinds. Some consist of a single bony piece, usually hard and pointed, sometimes flexible and elastic, and divided longitudinally; they are called *bony* or *spinous rays*: the others are composed of a vast number of little joints, generally branched at the extremity; they are called *soft*, *jointed*, or *branched rays*. In general the fins, which are placed in pairs, and correspond to the ordinary extremities, are four in number; but sometimes there are but two, and sometimes they are entirely wanting. When both pectoral and ventral fins are present, they may have the ordinary relative position; i.e. the pectoral fins may be considerably in advance of the ventrals—such fishes are said to be *abdominal*; or the ventrals may be placed below, or on the same or nearly the same transverse line as the pectorals—such fishes are termed *thoracic*; or the ventrals may be situated in advance of the pectorals, under the throat of the fish—when the species are called *jugular* fishes. The vertebræ of fishes, when completely ossified, are united, with very few exceptions, by opposite concave surfaces. Most fishes have the body covered with scales. They are destitute of organs of prehension, except the teeth. The imperfection of the organ of touch is remedied in some by the developement of soft tentacles or feelers.

The teeth are very various as to their number, form, and relative size. They are either anchylosed to the jaw-bones, attached to ligaments, or implanted in sockets; when the latter, the tooth has always a single and simple fang. The teeth may be placed on the maxillary, premaxillary, or lower jaw-bones: upon the vomer or sphenoid bones; upon the palatine or pterygoid bones, the tongue, the branchial arches, or the pharyngeal plates; or they may be entirely wanting.

Besides the branchial arches, the hyoid bone supports on each side a number of rays, which support the branchial or opercular membrane. This membrane is also generally further strengthened by three osseous plates called the *opercular*, *subopercular*, and *interopercular* bones: the kind of door thus formed is joined by the *preopercular* to the tympanic bone, and plays upon the *scapular arch*.

With respect to the subdivision of the class of fishes into orders, Cuvier, admitting the great difficulty which exists in defining them by fixed and easily appreciable characters, adopted after many attempts the following classification.

He first divided the class into two sub-classes:

Sub-class I. *Pisces ossei*, or fishes properly so called.

II. *Pisces cartilaginei*, or *Chondropterygians*, cartilaginous fishes.

The first sub-class are arranged according to the modifications of their organs of locomotion. All the osseous fishes which have the anterior part of the dorsal fin, or the first dorsal where there are two, supported by bony rays, with some bony rays in the anal fin, and at least one bony ray in each of the ventrals, are collected into an order, called *Acanthopterygians*.

All those osseous fishes in which, with the exception of the anterior dorsal and pectoral rays, all the rays are soft, constitute the order *Malacopterygians*.

The *Malacopterygii* are subdivided, according to the relative position or absence of the ventral fins, into *abdominal*, *jugular*, or *sub-brachial*, and *apodal* fishes.

Those fishes which have the branchiæ in the form of tufts constitute the order of *Lophobranchii*.

Those fishes in which the maxillary and palatine arches are firmly united, or as it were soldered to the cranium, are called the *Plectognathi*.

The *Chondropterygian* fishes are divided into the three orders of:—

Sturionians,
Selacians, and
Cyclostomes [which see]

The chief modification in the arrangement of the class of fishes has been the consequence of a study of the nature and affinities of the numerous extinct forms, and a comparison of these with existing species.

M. Agassiz has proved that certain species, which stand out as exceptions to the ordinary form and structure of the class among recent fishes, are the types of extensive orders which peopled the seas of the ancient world, and now characterise particular strata. This naturalist has likewise observed more closely than his predecessors the relations which subsist between the external scales and the internal structure; and he accordingly proposes to arrange the class of fishes according to the modifications of the scaly covering, and divides them into four orders, each of which contains fishes having a cartilaginous skeleton: and in each there are both Acanthopterygian and Malacopterygian, Abdominal and Apodal genera. These orders are named PLACOIDES, GANOIDES, CTENOIDES, and CYCLOIDES [which see].

The discovery of intermediate forms, between the true fishes and the lower reptilia, e. g. *Lepidosiren* and *Archegosaurus*, has induced Prof. Owen to regard the groups Pisces and Reptilia no longer as separate classes, coequal with the birds and mammalia, but to subordinate them as subclasses of the great group HÆMATOCRYA or cold-blooded vertebrate animals [which see]. In that article is a list of the orders of fishes, with those of Reptilia.

Ichthyophagist (Gr. ἰχθυοφάγος). A fish-eater. Some savage tribes who live almost entirely on fish were called by the ancients *Ichthyophagi*.

Ichthyophthalmite (Gr. ἰχθύς, and ὀφθαλμός, *the eye*). A species of zeolite with a peculiar pearly lustre, resembling that of the eye of a fish.

Ichthyopterygia (Gr. ἰχθύς, and πτέρυξ, *a fin*). An order of fossil reptiles in which the vertebral centra are ossified and biconcave; joined by syndesmosis, not by suture, to their neural arch. Pleurapophyses of the trunk long and bent, the anterior ones with bifurcate heads. Teeth with converging folds of cement at their base, implanted in a common alveolar groove, and confined to the maxillary, premaxillary, and premandibular bones. Premaxillaries much exceeding the maxillaries in size; orbit very large, a circle of sclerotic plates; nostrils near the orbits; limbs natatory, with more than five multi-articulate digits; an episternum and clavicles; no sacrum. The bones of the head, as in *Ganocephala*, include the supplementary postorbitals and supratemporals, and there is a foramen parietale, but there are small temporal and other vacuities between the cranial bones, a single convex occipital condyle, and one vomer which is edentulous. The order, which ranged from the lias to the chalk (excepting in the Wealden) inclusive, includes the genus *Ichthyosaurus*.

Ichthyosaurus (Gr. ἰχθύς, and σαῦρος, *a lizard*). A genus of extinct marine animals, which combined the characters of saurian reptiles and of fishes with some of the peculiarities of the Cetaceous Mammalia. The vertebræ of the backbone of the *Ichthyosauri* resemble those of fishes in having their bodies joined by opposite concave surfaces; but the superior arches remain permanently detached, as in reptiles. The cranium resembles in structure that of the crocodiles, but is characterised by a peculiarly large orbit, in which a circular series of osseous sclerotic plates, analogous to those of the crocodile and birds, but relatively much larger, has been so frequently found as to prove it to be a generic structure. The nostrils are situated, not, as in the crocodile, near the point of the snout, but close to the anterior part of the orbit.

The teeth resemble in structure those of the crocodiles; but are lodged, as in some of the Lacertine Sauria, in a groove, and not in distinct sockets. The locomotive extremities are similar in construction to the paddles of the whale; but they are four instead of two in number, and the anterior paddles are connected by a broad coracoid, a complete clavicle, and a supplementary coracoid bone to a strong sternum; the flattened phalangeal bones supporting the fin are polygonal, and are relatively shorter and more numerous than in the whale tribe. The hind paddles are smaller than the fore, and are attached to a pelvis similar to that of the crocodile. Small supplemental bones are wedged into the lower part of the joint of the atlas and occiput, and a few of the succeeding vertebral joints; and the tail often presents a fracture at a particular point, whence the existence of a caudal fin has been inferred. From the form and position of masses of crushed and apparently half-digested fish bones and scales in the abdominal cavity of the ichthyosaurus, it is concluded that they preyed chiefly on fish; that they had a simple and capacious stomach, and an intestine provided with a spiral valve. The geological range of the ichthyosaurus, according to Dr. Buckland, began with the muschelkalk and extended through the whole of the oolitic period into the cretaceous formation. The most recent stratum in which any remains of this genus have yet been found is the chalk marl at Dover. The chief British depository of the bones of the *Ichthyosauri* occurs in the lias at Lyme Regis in Dorsetshire.

Ichthyosis (Gr. ἰχθύς). A roughness and thickening of the skin, portions of which become hard and scaly, and occasionally corneous, with a tendency to excrescences. Friction, warm baths, and occasionally stimulating ointments, have been of service in mitigating the progress of this disease; but it seldom yields permanently to any plan of treatment.

Ichthys (Gr. ἰχθύς, *a fish*). A word found on many seals, rings, urns, tombstones, &c., belonging to the early times of Christianity, and supposed to have a mystical meaning, from each

character forming an initial letter of the words Ἰησοῦς Χριστός, Θεοῦ Υἱός, Σωτήρ; i.e. Jesus Christ, the Son of God, the Saviour.

Icica (the name in Guiana). A tropical genus of *Amyridaceæ*, consisting of large trees abounding in balsamic or resinous juice. The balsam obtained from many of the species is odoriferous, and is used as a perfume in South America. These balsams remain fluid for a considerable time, but ultimately harden, when they are used as incense. *I. heterophylla* yields Balsam of Acouchi, employed as a vulnerary; while that of *I. heptaphylla* is used as a remedy for dysentery, &c. The wood of *I. altissima* is preferred by the Indians for making canoes, and is called Cedarwood from its fragrance. It grows in the forests of Guiana to the height of one hundred feet or more.

Iconoclasts (Gr. εἰκών, *an image*, and κλάω, *I break*). Literally, breakers of images; a title applied to two of the Byzantine emperors, Leo the Isaurian and his son Constantine Capronymus, who during their reigns, which extended from 726 to 795, persevered in overthrowing the images in the Christian churches, and in extirpating their worship. The 338 bishops, also, who attended a council at Constantinople in the reign of the latter prince, and declared themselves in favour of his views, were stigmatised by the orthodox party under the same name. In the year 787, however, a general council was assembled at Nicæa by the empress Irene, who inclined towards the old superstition, and the images were on this occasion restored to their former honours. This council, the second of Nice, is the last respecting which the Greek and Latin churches coincide; the practice, however, of the Greek church makes a distinction between the use of pictures, which it allows, and graven images, which it studiously rejects. (Mosheim, *Eccl. Hist.*; Schlosser's *History of the Iconoclast Emperors*, Frankfort 1812; Stanley's *Lectures on the Eastern Church*; Milman, *Latin Christianity*, book iv. chap. vii.)

Iconography (Gr. εἰκονογραφία). A term invented to designate literary works devoted to the description of monuments of art; and, in a more restricted meaning, of portraits. Among works on this subject, Didron's *Iconographie Chrétienne* may be specially mentioned. Iconology is the explanation of emblematic and allegorical representations.

Icosahedron (Gr. εἰκοσάεδρος). A solid figure bounded by twenty planes. One of the five Platonic bodies or regular polyhedra is an icosahedron. It has twenty equal faces, each of which is an equilateral triangle; it has thirty edges, and twelve solid angles, each formed by the meeting of five plane angles. The total surface of a regular icosahedron is 8·6602540 times the square on one of its edges, and its volume is 2·1816951 times that of the cube on one of its edges.

Icosandrous (Gr. εἴκοσι, *twenty*, and ἀνήρ). Literally, any flower having twenty stamens or thereabouts; but it is usually confined to those flowers in which these stamens are inserted into the calyx.

Icterus (Gr. ἴκτερος). The jaundice: so called from its resemblance to a bird of yellow colour, so named, but now unknown.

Ictides (Gr. ἴκτις, *a weasel*). A genus of nocturnal carnivorous Mammals, intermediate between the Plantigrade and Viverrine Digitigrade tribes, having the plantigrade walk of the racoons and coatis, and the slender conical snout of the civets and other *Viverridæ*. The dental formula of the genus is—

$$i. \frac{6}{6};\ c. \frac{1-1}{1-1};\ p. \frac{3-3}{2-2};\ m. \frac{3-3}{3-3} = 38.$$

The teeth resemble those of the *Paradoxurus*, but are thicker and more tuberculous; and thus contribute, with the plantigrade structure of the foot, to indicate the affinity of the *Ictides* to the plantigrade *Feræ*. Three species are recorded; they are all natives of Southern Asia, and are called Benturongs. The common Indian species (*I. albifrons*) is of the size of a domestic cat; but its body is longer and heavier, its legs shorter, and its gait lower and more crouching. The tail is extremely thick at its commencement, and gradually tapers to the extremity, where it curves upwards. The pupil of the eye contracts during daylight into a vertical fissure. A Benturong, which was kept in captivity many years, was fed on a mixed diet of animal and vegetable substances; and they most probably subsist on similar food in a state of nature.

Idea (Gr. ἰδέα). Literally, the image or resemblance of any object conceived by the mind. There is no word in any language the definition of which, from the obscurity of metaphysical writers, is attended with such difficulty as the term *idea*; and the difficulty is enhanced when we consider the vagueness with which its equivalents are expressed in different languages. Like many other terms of mental philosophy, the word *idea* is derived from the sense of sight, and in its most extended acceptation is employed to indicate 'every representation of outward objects through the senses, and whatever is the object of thought.' (Dugald Stewart's *Phil. Essays*, Appendix ii.; Kant's *Critik der reinen Vernunft*; Ritter's *Geschichte der Philosophie*; Reid *On the Human Mind*; J. S. Mill, *Examination of Sir W. Hamilton's Philosophy.*)

Ideal (Gr. ἰδέα). In Painting and Sculpture, the ideal is an image formed in the mind, as the result of knowledge and experience, and based on the material or natural image. The *beau ideal* is an ideal beauty composed of a selection of beautiful parts, and put into harmony with each other by the skill of the artist. There can be no definite canon as to what constitutes the beau ideal, as each artist, according to his taste, skill, or experience, will imagine a different standard; thus the ideal of one school differs from the ideal of another, as much as complexion and temperament differ in the various races. Most great painters and sculptors have esta-

blished their own ideal, and this has been delightful to others in proportion to the extent of the powers of the artist. Guido painted Madonnas and Magdalens from the head of his colour-grinder, his model constituting merely the basis of his ideal. Raphael, in a letter to Count Castiglione, very clearly states his recourse to an *ideal* standard in painting his Madonnas; he says, 'To paint a beautiful woman, I must see several; but as there are few beautiful women, I have recourse to a certain *ideal* in my mind. Whether this be beneficial to art, I know not; but I strive to form such an *ideal* in my mind.'

Zeuxis adopted the same principle, when employed by the citizens of Croton to paint a figure of Helen: he obtained five of the most beautiful virgins of the city as his models, and from each adopted what according to his ideal was most beautiful, and thus produced his famous picture. (Wornum, *Epochs of Painting*, 1864, pp. 37–329.)

Idealism. A term applied to several metaphysical systems, varying in its signification according to the meaning attached in each particular scheme to the word *idea*; from which it is derived. In England the best known system of idealism is that of Berkeley. In reference to this philosopher's doctrines, the word is used in its empirical sense for the object of consciousness in sensation. [PERCEPTION.] In its Platonic or transcendental sense, the term *idealism* has been applied to the doctrines of Kant and Schelling; neither of whom is an idealist in the way in which Berkeley may be so called. The system of Berkeley may be thus expressed: The qualities of supposed objects cannot be perceived distinct from the mind that perceives them; and these qualities, it will be allowed, are all that we can know of such objects. If, therefore, there were external bodies, it is impossible we should ever know it; and if there were not, we should have exactly the same reason for believing there were as we have now. All, therefore, which really exists is spirit, or the thinking principle—ourselves, our fellow men, and God. What we call ideas are presented to us by God in a certain order of succession, which order of successive presentation is what we mean by the laws of nature.

Identigraphy (a word made up from Lat. idem, *the same*, and Gr. γράφω, *I write*). A name given by the Dutch periodicals in 1825 to an application of the art of lithography, by which a reprint of common letterpress printing is obtained in a short time, according to the inventor in two hours after the arrival of the mail. [ANASTATIC PRINTING.]

Identity, Personal. The sameness of the conscious subject, *I*, throughout all the various states of which it is the subject. The question, Wherein consists our identity, and what is its evidence? has been a source of manifold controversy to modern metaphysicians. By philosophers of the materialist school the doctrine has been ejected, as incompatible with daily and obvious experience. But independently of any hypothesis respecting the nature of the soul in itself, it has been argued, that as all our knowledge of a substance is derived from the qualities or phenomena which it presents to our senses, and that all we can mean by a substance being the same with itself is that it possesses the same qualities which it previously did (for if not, the substance is changed), so all we can know of the substance *mind* in particular is derived from observation of the changes which it undergoes. But we find that what we conceive to be the same individual does, at different periods, assume under the same circumstances widely varying appearances. A man will laugh at what when he was a child would have excited his anger or jealousy. This reasoning contains an evident fallacy. It does, in fact, like all other reasoning of the same kind, imply that very doctrine which it means to refute. Consciousness, it is asserted, is the joint effect of two substances acting one on the other. How, then, can we affirm that one of these substances is changed, unless by assuming that the other remains the same? How can we show that the phenomenon laughter in the man is different from the phenomenon jealousy or anger in the boy, unless we admit that we who *observe* these phenomena—i. e. by the premisses, on whom these phenomena produce a given effect—remain the same as we were when we were affected previously in a different manner. A lump of sugar, as we take it to be, no longer melts in what we take to be water. Assuming that the water remains water, we may fairly infer that the lump in question is not sugar, or vice versâ; not so if we profess ourselves equally ignorant of the identity of both substances. This argument, it will be seen, applies equally to the materialist and non-materialist. Such may be said to be the *negative* evidence of our identity. Its positive evidence rests on the necessity and universality of its belief, as implied in every act of memory. *To remember* is to refer a past state of consciousness to the same subject which now at the present moment recalls it. (Bishop Butler's *Treatise on Personal Identity*; Brown's *Phil. of Human Mind*, Lect. 12, 13, 14, &c. &c.)

Identity, System of. In Philosophy (otherwise called Identism), a name which has been given to the metaphysical theory of the German writer Schelling. It rests on the principle that the two elements of thought, the objects respectively of understanding and reason, called by the various terms of *matter* and *spirit*, *objective* and *subjective*, *real* and *ideal*, &c., are only relatively opposed to one another as different forms of the one *absolute* or *infinite*; hence sometimes called the two *poles* of the absolute. [SCHELLING, PHILOSOPHY OF.]

Ideographic Characters (Gr. ἰδέα, and γράφω). In Philology, characters used in writing which express figures or notions, instead of the arbitrary signs of the alphabet. The Chinese characters are ideographic, al-

though the symbols, at first intended to represent distinct objects, have become by use merely conventional. The hieroglyphical characters of the ancient Egyptians were of the same description. Ideographical writing is opposed to phonetic. [PHONETIC; ALPHABET.]

Ideology (Gr. ἰδέα, and λόγος). Literally, the science of mind. The term applied by the later disciples of Condillac to the history and evolutions of human ideas, considered as so many successive modes of certain original or transformed sensations. The writings of this school are characterised by an unrivalled simplicity, boldness, and subtlety; and the different phases of its doctrines are admirably exhibited in the physiological researches of Cabanis, the moral dissertations of Garat and Volney, and the metaphysical disquisitions of Destutt de Tracy. (Damiron, *Hist. de Phil. en France*, &c. &c.)

Ides (Lat. idus). One of the three epochs or divisions of the ancient Roman month. The *calends* were the first days of the different months; the *ides*, days near the middle of the months; and the *nones*, the ninth day before the ides. In the months of March, May, July, and October, the ides fell on the 15th; in the other months on the 13th. The Romans used a very peculiar method of reckoning the days of the month. Instead of employing the ordinal numbers first, second, third, &c., they distinguished them by the number of days intervening between any given day and the next following of the three fixed divisions. For example, as there were always eight days between the nones and the ides, the day after the nones was called the eighth *before* the ides, the next the seventh *before* the ides, the next the sixth *before* the ides, and so on. In leap years, when February had twenty-nine days, the extra day was accounted for by calling both the twenty-fourth and twenty-fifth days of that month the sixth day before the calends of March; whence the leap year received the name BISSEXTILE [which see].

Idiom (Gr. ἰδίωμα, from ἴδιος, *peculiar*). In Philology, a mode of speaking or writing foreign from the usages of universal grammar or the general laws of language, and restricted to the genius of some individual tongue. Thus, a sentence or phrase consisting of words arranged in a particular manner may be a Latin idiom; the same, arranged in a different manner, an English idiom, &c. The use of a particular inflexion of a word may also be an idiom. We also use the term *idiom* in a wider sense, to express the general character of a language. We have a number of subordinate words to express the idioms of particular tongues: thus, a Latin idiom is a Latinism, a French idiom a Gallicism, &c. The word *idiom* is also not uncommonly, but incorrectly, used in the same sense with the French *idiome*, a dialect or variety of language. *Idiotisme* is the French term expressing the correct signification of the English *idiom*.

Idiopathic (Gr. ἴδιος, and πάθος, *an affection*). A disease which does not depend upon any other disease, and which is thus opposed to those diseases which are *symptomatic*.

Idiosyncrasy (Gr. ἴδιος; σύν, *with*; and κρᾶσις, *a temperament*). A state of constitution peculiarly susceptible of certain agents which in general produce no effect, or one perfectly different. Thus honey and coffee act with some few persons as violently aperient; very minute doses of antimony are occasionally followed by powerful emetic effects, and small quantities of mercury by salivation, &c.

Idiot (Gr. ἰδιώτης, originally *a private individual*). In contemplation of Law, one who has been born totally deficient in understanding, or has lost it by sickness, so as to have no lucid intervals: lunatic, properly speaking, one who has lucid intervals. The care of idiots and lunatics is a branch of the prerogative of the crown, and exercised ordinarily by the chancellor. [LUNATIC.]

Idocrase (Gr. εἶδος, *appearance*, and κρᾶσις, *mixture*, indicating that its forms are a mixture of those of certain other minerals). Volcanic Garnet. It is of various colours, and is sometimes called Volcanic Chrysolite or Hyacinth. It occurs in the ejected masses of Vesuvius, and elsewhere. It is an alumino-silicate of lime, with about 5 per cent. of oxide of iron.

Idol, Idolatry (Gr. εἰδωλολατρεία, from εἴδωλον, *an image*, and λατρεία, *service*). The figures of metal, stone, or wood, by which pagans for the most part represent their divinities are termed *idols*, and the worship paid to them *idolatry*. Although Grecian idolatry was dignified by all the charms which art could throw around it, it appears that the most popular idols were rude and almost formless images; traditionary representations of the divinities, to many of which the vulgar notion attributed a divine origin, believing them to have fallen from heaven. Such were the Hermæ of Athens; the image of Artemis or Diana at Ephesus, mentioned in the Acts of the Apostles; the sacred *ancile*, or shield of the Romans: which seems to have commanded more of the veneration of the common people than the Pallas of the Parthenon or the Jupiter Olympius of Elis. (Vossius, *De Origine Idololatriæ*; Graves *On the Pentateuch*; Creuzer, *Symbolik der alten Voelker*; Spence's *Polymetis*; *Mém. de l'Acad. des Inscr.* vol. xxxviii. Thirlwall, *History of Greece*, vol. i. ch. vi.)

Idrialine. A fusible inflammable substance, found by Dumas in a mineral from the quicksilver mines of Idria in Carniola.

Idryl. A fusible volatile hydrocarbon derived from Idrid coal by distillation.

Idyll (Gr. εἰδύλλιον, the diminutive of εἶδος, *form*). A short pastoral poem of which the object, or at least the necessary accompaniment, has been said to be a vivid and simple representation of ordinary objects in pastoral nature. But in common usage the signification of this word is hardly different from that of eclogue. The pastoral poems of Theocritus are termed *Idylls*, those of Virgil *Eclogues*; but it would

be difficult to assign any distinction between the two, except that which arises from the greater simplicity of language and thought which characterises the former. Many critics, however, aver that the eclogue requires something of epic or dramatic action: the idyll only picturesque representation, sentiment or narrative. [ECLOGUE; BUCOLIC.] In English poetry, among this class may be ranked, Shenstone's *Schoolmistress*, Burns' *Cottager's Saturday Night*, Goldsmith's *Deserted Village*, &c. &c. Mr. Tennyson's celebrated volume, *The Idylls of the King*, is in truth misnamed.

Igasuric Acid. A name given by Pelletier and Caventou to an acid which is found combined with strychnia in the *Nux vomica* and St. Ignatius's bean.

Iglite or **Igloite.** A variety of Aragonite found at Iglo in Hungary.

Ignatius's Bean. The seeds of a plant supposed to be the *Strychnos multiflora*, used in the Philippine Islands as a cathartic and emetic. [STRYCHNIA.]

Igneous Rocks (Lat. igneus, *fiery*). The materials poured out in a molten state from volcanoes [VOLCANO], or thrown out as ashes, lapillæ, or scoriæ, are beyond a doubt igneous rocks, and the large quantity of such materials that must exist, but is not poured forth, in the neighbourhood of volcanoes, is also of the same nature. Ancient lava exists, and is called *basalt*. But besides lava and basalt there are many varieties of igneous rock, which may, in many cases, be results of submarine eruption, the lighter matter, if any, erupted at the same time having been carried away and levelled by the action of water, and the point of eruption not being developed into a volcano. Many of the largest eruptions of lava have taken place at the sides of the cones, at a distance from the hill, whence smoke and gaseous products issue.

Igneous rocks are of all geological periods, but in proportion as they are more ancient they are the more likely to be obscure. Thus in the older rocks lava is no longer recognisable. Basalt there becomes greenstone, and is often so far metamorphosed as to simulate true porphyry. Volcanic ashes become regularly stratified, and difficult to distinguish from other mechanical rocks of similar mineral composition.

Igneous rocks are not to be confounded with hypogene or plutonic rocks, which have been also apparently formed with much heat and under enormous pressure, but which have not, so far as we can tell, been directly melted by heat, and were not erupted. The difference is very marked, and can generally be determined by microscopic examination of thin sections. The blebs or vesicles in the one are occupied by air or filled by crystalline minerals; those in the other are filled by water. The amount of pressure under which the rocks have been elaborated, induces differences so important that it is often difficult to identify similar minerals; but in fact the nature of the minerals formed out of a given proportion of certain elements varies very greatly, and according to laws with which we are only now beginning to become acquainted.

Strictly and properly speaking, then, none are igneous rocks but those which we know to have existed in their last state in a molten form, so that lava, scoriæ, or the stony froth of lava, and ashes, or the fine dust of the scoriæ, can alone be named among modern rocks, and basalt and greenstone among the older. The greenstones, however, although sometimes certainly basaltic, are sometimes of doubtful origin. Porphyries of the more familiar kind, such as granite and syenite, are certainly not igneous in the proper sense, nor are the contents of veins in these rocks. All these are more properly METAMORPHIC [which see].

Ignis Fatuus (Lat. *vain or foolish fire*; a translation of the Fr. feu follet). A kind of luminous meteor, which is said to flit about in the air a little above the surface of the earth, and to appear chiefly in marshy places, or near stagnant waters, or in churchyards, during the nights of summer. Many instances are related of travellers having been decoyed by these lights into marshy places, where they perished; and hence the names *Jack-with-a-lantern, Will-with-a-wisp*: the people ascribing the appearance to the agency of evil spirits, who take this mode of alluring men to their destruction.

This somewhat dubious phenomenon has not yet received a satisfactory explanation. It cannot be referred to natural issues of spontaneously inflammable gas, since no natural production of such gas has ever been observed; neither can it be due to phosphorescence, for this kind of luminosity is too feeble to be seen at a distance. Divested of its imaginary attributes, the phenomenon may probably be referred to the issue of marsh-gas (light carburetted hydrogen) from the earth. This gas being ignited, either accidentally or intentionally, continues to burn with a flame invisible at a short distance in daylight, but sufficiently luminous to be well seen at night.

Ignition (Lat. ignis, *fire*). The act of setting fire to, or of taking fire; as opposed to combustion or burning, which is a consequence of ignition. The term *spontaneous ignition* is applied to cases in which substances take fire without previous application of heat: thus spongy platinum is said to become spontaneously ignited when introduced into a mixture of oxygen and hydrogen gases, and to cause their combustion. The particles of steel struck off by collision with flint become ignited on passing through the air, and falling upon gunpowder ignite it, and combustion ensues. Iron wire, when red hot, is also often said to be *ignited*, or in a state of ignition; and when in that state it is plunged into oxygen gas, or into chlorine, it undergoes combustion, and burns in those gases with the further extrication of heat and light.

The term *spontaneous ignition* is also ap-

plied to cases of the accumulation of heat as a result of the oxidation or eremacausis of certain kinds of vegetable matter, so as to occasion them to burst into flame. [EREMACAUSIS.] Cotton, flax, tow, jute, and other such substances in a damp or in a greasy state are subject to this form of spontaneous ignition. The heaps of greasy cotton-waste used in wiping and cleaning machinery have in this way become the source of calamitous fires.

Ignoramus (Lat. *we are ignorant*). In Law, the endorsement of a grand jury on a bill of indictment, equivalent to *not found*. The jury are said to *ignore* a bill when they do not find the evidence such as to make good the presentment. The Latin form is now disused.

Iguana (Cuvier states, with reference to the derivation of this term, that it was originally a St. Domingo word, where it was pronounced by the natives *hiuana* or *igoana*, and quotes Hernandez and Scaliger as his authorities. He then proceeds to say that Bontius regards it as derived from the Japanese word *leguan*. In this case the Portuguese or Spaniards must have transported it to America, where they transformed it into *iguana*. They apply this term to the monitor as well as to the *iguana*. The *leguan* of Bontius is a monitor. The best authorities in herpetology have adopted the Latinised *iguana* as the generic name of the reptiles under consideration). A genus including certain large and beautiful lizards common in the tropical parts of America, some of which feed on vegetable substances, and are esteemed delicious food. The common iguana (*Iguana tuberculata*, Laur.) has accordingly received the specific names *delicatissima* and *sapidissima*. The generic name *iguana* is now restricted to those species which present the following characters: A large thin fold of skin or dewlap under the chin; cephalic cuticular plates, polygonal, unequal in diameter, flat or carinated; a double row of small palatal teeth; maxillary teeth, with their edges finely dentilated; a crest on the back and tail; toes long and unequal; a single row of femoral pores; tail very long, slender, compressed, covered with small, equal, imbricated carinated scales.

Iguanidæ (from *Iguana*). The family of lizards, of which the genus *Iguana* is the type, and which is divided, according to minor modifications of the leading characters of the Iguanas, into the subgenera *Iguana* proper, *Corythophones*, *Basiliscus*, *Aloponotus*, *Amblyrynchus*, *Metopoceros*, *Cyclura*, *Brachylophus*, *Enyalus*, and *Ophryoëssa*.

Iguaninæ (from *Iguana*). The *Lézards iguaniens* of French herpetologists. This extensive tribe of Lacertine Sauria is divided by MM. Duméril and Bibron into two groups, *Pleurodontes* and *Acrodontes*.

The *Pleurodontes* include the families *Iguanidæ*, *Polychridæ*, *Anolidæ*, *Tropidolepidæ*, and *Opluridæ*.

The *Acrodontes* embrace the families *Galeotidæ*, *Agamidæ*, *Phrynocephalidæ*, and *Stellionidæ*.

A short and thick tongue, with base not retractable in a sheath, and with the extremity free, mobile, and very slightly cleft, is the general character of this extensive tribe.

Iguanodon (from *Iguana*; and Gr. ὀδούς, *a tooth*). An extinct genus of gigantic herbivorous reptiles, discovered by Dr. Mantell in the Wealden fresh-water formation of the South of England, in the localities of Tilgate Forest, Isle of Wight, and Purbeck. The chief distinctive character of this genus is the form of the teeth, which are dentilated along the margin of the crown, as in the *iguana*; but thicker, so as to present, when worn down, a broader grinding surface. The structure by which these teeth were adapted to the cropping of coarse and tough vegetable food, such as the *Clathrariæ* and similar fossil plants of the Wealden strata may be supposed to have afforded to the *iguanodon*, is thus described by Dr. Buckland: 'The teeth exhibit two kinds of provisions to maintain sharp edges along the cutting surface, from their first protrusion until they were worn down to the very stump. The first of these is a sharp and serrated edge, extending on each side downwards from the point to the broadest portion of the body of the tooth. The second provision is one of compensation for the gradual destruction of this serrated edge, by substituting a plate of thin enamel to maintain a cutting power in the anterior portion of the tooth until its entire substance was consumed in the service. Whilst the crown of the tooth was thus gradually diminishing above, a simultaneous absorption of the root went on below, caused by the pressure of a new tooth rising to replace the old one, until by this continual consumption at both extremities the middle portion of the older tooth was reduced to a hollow stump, which fell from the jaw to make room for a more efficient successor.' The anterior surface of the crown of the tooth also, instead of being flat and even, was traversed by alternate longitudinal ridges and furrows, the latter serving 'as ribs or buttresses to strengthen and prevent the enamel from scaling off, and forming, together with the furrows, an edge slightly wavy, and disposed in a series of minute gouges or fluted chisels; hence the tooth became an instrument of greater power to cut tough vegetables under the action of the jaw, than if the enamel had been a continuous straight line. By these contrivances also it continued effective during every stage through which it passed, from the serrated lancet point of the new tooth to its final consumption.

From the proportions which the bones of the *iguanodon* bear to those of the *iguana*, this extinct monster of a former world was thought to have been 70 feet in length from the snout to the end of the tail; the length of the tail alone being estimated at 50 feet; but recent discoveries have shown that the proportions of the trunk and tail were so modified as to reduce the total length of the animal to between 30 and 40 feet. The thigh-bone of the full-

sized *iguanodon* is twenty times the size of that of the *iguana*.

Ileum (Lat. ile, *a gut*, pl. ilia). The last portion of the small intestines, terminating at the valve of the cæcum.

Ilex (Lat.). The genus of the Holly, consisting of evergreen trees and shrubs, and a member of the order *Aquifoliaceæ*. The Common Holly, *I. Aquifolium*, is well known, with its glossy spinous leaves and coral berries, as one of our principal Christmas decorations. Of this there are an immense number of varieties in cultivation, differing in the form, size, and colouring of the leaves, and in the colour of the berries. The plant has also a medicinal reputation, the root and bark being expectorant and diuretic, the leaves febrifugal, and the berries purgative and emetic. The wood is used for inlaying, and the inner bark to form bird-lime. *I. paraguayensis* is the Matè of South America. [MATÉ.]

Ilia (Lat.). The flanks, or the part of the abdomen which includes the small intestines. The *os ilium* is the haunch-bone, the upper part of the *os innominatum*, which supports the intestines.

Iliac Passion (Lat. ilia, *the bowels*). A vomiting of bilious and fæcal matter in consequence of obstruction in the intestinal canal.

Iliad (Gr. Ἰλιάς). This poem, which is generally regarded as narrating the events of the war of the Achæans against Troy, consists, in the form in which it has been transmitted to us, of twenty-four books, which are still thought by a few to make up one poem composed by a single poet. This position is maintained by Mr. Gladstone in his work on *Homer and the Homeric Age*. Mr. Grote, on the other hand, in his review of the Homeric controversy, allows the possibility of its composition by one author, but maintains that it consists of at least two poems pieced together. This conclusion is grounded chiefly on the fact that the first book professes to be the beginning of a poem which relates the wrath of Achilles and the consequent helplessness of the Achæans. But this book is followed by several others which exhibit the Achæan chieftains in the full tide of success, and as being wholly forgetful or careless of the absence of Achilles. So again the poet, who relates in the closing books how, by restoring Briseis and confessing his fault, Agamemnon wipes out the old grudge, has forgotten that the same confession has been made, and an equal humiliation undergone long before. Mr. Grote's dissection of the several parts of the poem may be found in his *History of Greece*, part i. ch. xxi. But it must further be remarked that the poem, as thus pieced together, relates only a few episodes in the last year of the war. Hector, indeed, is slain; but Ilion is not taken, and it is reserved for the *Odyssey* to relate incidentally how Achilles was slain at the western gates by the spear of Alexandros or Paris. The whole poem would thus appear to be part of a long series of legends, relating to the same subject. For the connection of these legends with those of other Aryan nations, see MYTHOLOGY, COMPARATIVE. An analysis of the poems from nearly the same point of view as that of Mr. Gladstone is given in Mure's *Critical History of Greek Literature*, vol. i.; and in its solar aspect, in Cox's *Tales of Thebes and Argos*, pp. 63–85. [EPIC; HOMERIC POEMS.]

Ilicin (Lat. ilex). A neutral crystalline body, contained in holly-leaves (*Ilex aquifolium*).

Illative Conversion. In Logic, that conversion in which the truth of the converse follows from the truth of the exposita, or proposition given. Thus the proposition, 'No virtuous man is a rebel,' becomes by illative conversion, 'No rebel is a virtuous man.' 'Some boasters are cowards;' therefore, à converso, 'Some cowards are boasters.'

Illecebraceæ (Illecebrum, one of the genera). A small natural order of hypogynous Exogens, belonging to the Silenal alliance, allied to *Portulacaceæ*, *Caryophyllaceæ*, and *Amaranthaceæ*, and distinguished by having both calyx and corolla present and symmetrical, the latter rudimentary, and by its scarious stipules and amphitropal ovules. They are plants of no importance.

Illicium (Lat. illicio, *to allure*). To this genus of Magnoliads belongs the Star Anise, *I. anisatum*, the fruit of which forms a considerable article of commerce amongst Asiatic nations. This plant derives its popular name from the stellate form and anise-like odour of its fruits, which are used as a condiment, and also for chewing for the purpose of sweetening the breath. The oil obtained from them is substituted for oil of anise. *I. religiosum* is held sacred by the Japanese, who decorate the tombs of deceased friends with it, and burn the fragrant bark as incense. The leaves, however, are said to be poisonous; and those of *I. floridanum* have the same reputation, whence the latter plant has acquired the name of Poison Bay. They are all evergreen shrubs or low trees, with laurel-like leaves.

Illuderite. A mineralogical synonym of *Epidote*.

Illuminati or **The Enlightened.** A secret society, formed in 1776, chiefly under the direction of Adam Weishaupt, professor of law at Ingolstadt in Bavaria. Its professed object was the attainment of a higher degree of virtue and morality than that reached in the ordinary course of society. It numbered at one time 2,000 members. It was suppressed by the Bavarian government in 1784. It has been supposed that this and some other secret societies were actively engaged in preparing the way for the French revolution; but of this no satisfactory proof has been adduced. (*Ency. von Ersch and Gruber.*)

Illuminating Power. [TELESCOPE.]

Illumination, Art of. The practice of illuminating books with gold and colours seems to prevail generally in countries where printing is unknown, but where a written literature exists. With the introduction of printing it has invariably declined, if it has not altogether died out. In Arabia, Persia, &c., MSS. are

still so ornamented; in Europe it may now be regarded simply as an amusement for persons with ample leisure at their command. But during the early and middle ages of the Christian era, the highest specimens of art are to be found in the pages of MSS. The monastic system, by cutting off large numbers from all secular business, gave great impulse to the art, especially in application to the office books of the church. Many of these books, containing exquisite miniatures and borderings of flowers or other designs, are preserved in libraries and museums, and are invaluable as throwing light on the developement and history of art. The character of the illustrations, with the form of the letters, suffices to determine the age and country where the MS. was written; and a comparison of MSS. of Eastern and Western Europe brings before us the several stages which mark the growth of Christian iconography. (Didron, *Iconographie Chrétienne.*) The illuminated MSS. of historical works, as those of Froissart, Monstrelet, &c., are not less important, as illustrating the manners, costumes, and habits of life prevalent in the ages of which they treat. The devotion of the monastic illuminators to their work caused naturally a strong resistance to the introduction of printing, in which, however, books were for a long time prepared so as to resemble as closely as possible illuminated manuscripts.

Minute directions for the practice of this art, in which body colours are employed and the leaf-gold on size prepared in various ways, may be found in the curious work of Cennino da Colle, *De Arte Pingendi.* Imitations of illuminated works are now produced with more or less success by the process of printing; it is unnecessary to specify the many works so prepared by Messrs. Shaw, Owen Jones, Noel Humphreys, Pugin, &c.

Illumination of Wires. [MICROMETER.]

Illustration (Lat. illustratio). In Rhetoric, appears to differ from *comparison* or *simile* in this only, that the latter is used merely to give force to the expression; the former to throw light upon an argument. The term *illustration* is, however, sometimes used in a wider sense, in which it seems to comprehend *example*, which is the recital of a particular fact or instance evincing the truth of a general proposition laid down in the argument; and *parable*, which is a species of symbolical narrative, in which the actors and events are intended to represent certain other actors and events in a typical manner. [PARABLE.]

Illustrations. In Printing, the pictorial embellishments of a book, whether lithograph, copper-plate, or woodcut. The cheapest and, in some respects, the most effective are those on wood, worked in with the letterpress at one impression.

Ilmenite. A variety of Titaniferous Iron found crystallised and massive at Lake Ilmen, in Siberia: also in crystalline lamellar masses in the mica-schist of Glen Finnart in Argyleshire, Norway, &c.

Ilmenium. A metallic base, so called because its ore, *Yttro-ilmenite*, is found near the Ilmen mountains in Siberia. Rose believes this metal to be identical with *niobium* or *columbium.*

Ilvaite. A mineral found in *Elba*, in black prismatic crystals: it is a silicate of iron and lime.

Ilyanthus (Gr. ἰλύς, *mud*, and ἄνθος, *a flower*). A genus of non-adherent Sea Anemones, with a proportionally larger column than in most true *Actiniæ.*

Image (Lat. imago). A representation of the Deity in stone, wood, or metal. [IDOL.] For the principal events in the history of Christian image worship, see ICONOCLASTS.

IMAGE. In Optics, the spectrum or appearance of an object, made by reflection or refraction; or the *image* of an object may be more correctly defined as the locus of all the pencils of converging or diverging rays emanating from every point of the object, and received on a surface. It is by means of optical images that vision is effected. The eye is an assemblage of lenses which concentrate the rays emanating from each point of the object on a tissue of very delicate nerves called the *retina*, where an exact image or representation of the object is formed; and it is this image which is perceived or *felt* by the retina.

The images of external objects are painted on the retina in a reversed position, and from the retina the impressions are transmitted to the sensorium by the optical nerves. [EYE; OPTICS.]

IMAGE. In Rhetoric, a term somewhat loosely used; it appears generally to denote a metaphor dilated, and rendered a more complete picture by the assemblage of various ideas through which the same metaphor continues to run, yet not sufficiently expanded to form an allegory.

Imagery. May be defined as the generic term for *similes*, *allegorics*, and *metaphors*, or such rhetorical figures as denote similitude or comparison.

Imaginary (Lat. imaginarius). In Algebra, a quantity is said to be imaginary when its symbolical expression involves the impossible operation of taking the square root of a negative quantity. The general form of such a quantity is $a+b\sqrt{-1}$, where a and b denote real magnitudes. By operating upon such quantities in the same manner as we do upon real ones, algebra gains, as it were, a double power. For instance, an equation of the form

$$a+b\sqrt{-1}=c+d\sqrt{-1}$$

involves the equalities $a=c$ and $b=d$. We find, too, that the intelligible, or rather the interpretable, results of algebraical operations are never vitiated by this mode of procedure, whilst uniformity in the enunciation of theorems and many other advantages are thereby secured. Thus, when we say that an equation has *always* a root, we mean that an expression of the form $a+b\sqrt{-1}$, where a and b are real (possibly 0), always exists which, substituted for x in that

equation and treated accordingly, will satisfy it identically. The imaginary or impossible character of symbolical expressions of the above kind, however, proceeds from the prescribed meanings attributed to the several symbols. The results of algebra, regarded as the science of the combination of symbols according to prescribed laws, are all equally real. If in accordance with these laws we attach a meaning to the symbols, the results in question will be true whenever they are intelligible, but they will not necessarily be always intelligible. Thus if, as in ordinary arithmetic, + and − denote simply the operations of addition and subtraction, and a and b represent numbers, $a-b$ will be imaginary or impossible whenever b exceeds a. On the other hand, if + and − denote progression in opposite directions on a straight line, $a-b$ will be perfectly intelligible whatever may be the relative magnitudes of the distances a and b. By recognising directly opposite directions, therefore, we escape certain anomalies, and found a more extended *single algebra*. In this system, however, $\sqrt{-1}$ would still remain without significance. Analogy suggests now the recognition of more than two directly opposite directions, and since $\sqrt{-1}$ denotes an operation which, twice repeated upon a magnitude (line) b, converts it into $-b$, we come to regard $b\sqrt{-1}$ as a line of the length b, *turned from its initial position through a right angle*, and by an obvious extension $a+b\sqrt{-1}$ then denotes the hypothenuse of a right-angled triangle, one of whose sides a has the initial direction, whilst the other, b, has a direction at right angles to the first. Thus arises a *double algebra* of a still more general character, and still more free from imaginary or impossible symbolical results. On this subject the reader may consult with advantage Peacock's 'Report on Certain Branches of Analysis,' in the *Transactions of the British Association*, 1834; De Morgan's *Trigonometry and Double Algebra*, London 1849; or the article 'Negative and Impossible Quantities,' in the *Penny Cyclopædia*.

The application of algebra to geometry naturally led to the application of the term *imaginary* to points, lines, &c., which cease to exist, actually, when the magnitudes or positions of certain elements of a figure are varied. Thus we speak of the *imaginary points* common to a line and a circle which do not intersect one another, meaning thereby the points whose coordinates would have the form $a+b\sqrt{-1}$, but would nevertheless satisfy, simultaneously, the equations of the circle and of the line. [CIRCULAR POINTS AT INFINITY.]

Imaginary Roots of an Equation. Expressions of the form $a+b\sqrt{-1}$, where a and b denote real numbers, which, when substituted for the unknown quantity x, and treated according to the ordinary laws of algebra, reduce the equation to an identity. [EQUATION.] If $a+b\sqrt{-1}$ is a root of an algebraical equation $F(x)=0$ whose coefficients are all real, then the *conjugate* expression $a-b\sqrt{-1}$ is also a root, and

$$(x-a-b\sqrt{-1})\,(x-a+b\sqrt{-1})=(x-a)^2+b^2,$$

which is necessarily positive for all values of x, is a factor of $F(x)$. Besides the ordinary arithmetical root, every number a has also imaginary roots which are found by multiplying the former by the imaginary ROOTS OF UNITY.

Imagination (Lat. imaginatio). In Metaphysics, may be said, in its widest sense, to be synonymous with *invention*, denoting that faculty of the mind by which it either 'bodies forth the forms of things unknown,' or produces original thoughts or new combinations of ideas from materials stored up in the memory. While some (and among these Reid and Addison) limit the domain of this faculty so far as to teach that it is nothing more than a *lively conception* of the objects of sight, differing from conception only as a part from the whole; others, like Dugald Stewart, place it in the foremost rank of the mental faculties, attributing to its operation the origination and developement of the sublimest and boldest thoughts in all the departments of human knowledge. Dr. Reid's chapter *On the Train of Thought in the Mind* gives a vivid though simple picture of the power of the imagination; while, at the same time, it illustrates the difficulty of treating this subject, owing to a want of precision in the definition of the term. In many philosophical disquisitions imagination is used as nearly synonymous with *fancy*. But it would seem that this is an erroneous application of the term; for, as Dugald Stewart observes, the latter should rather be considered as that peculiar habit of association which presents to our choice all the different materials that are subservient to the efforts of the former, and which may therefore be considered as forming its groundwork. [ASSOCIATION; POETRY.]

Imago (Lat.). In Entomology, the term applied to the state of the butterfly after it has emerged from the *pupa*.

Imaum or **Imân.** An inferior order of ministers of religion in the Turkish empire. The chief imaum of each mosque (Imam'ul-Haikh) performs the ordinary civil functions which in Europe have been in most countries assigned to parish priests, assisting at the circumcision, marriages, burials, &c. of his parishioners. He presides over the assembly of the faithful at the ordinary prayers; but the solemn noon prayer on Friday is under the superintendence of the Khatib, a higher minister (who is also called from that circumstance the *Imam'ul Djumâ*, or Friday Imân). The legitimate successor of Mahomet, who, in theory, is primarily an ecclesiastical chief, is termed *Imâm* by way of pre-eminence; but the Mussulmans are not agreed among themselves as to the character of this dignity, or as to those who have rightfully borne it. The Persians reckon twelve legitimate Imaums, of whom they believe the last (Mahadi) to be still living. (Taylor's *History of Mohammedanism*, ch. viii.)

Imbecility (Lat. imbecillitas, *weakness*). In Law, the state of a person who, although not positively non compos, or insane, is yet of such great weakness of mind as to be unable to guard himself against imposition, or to resist importunity or undue influence. (Story's *Equity Jurisprudence.*) Equity will not set a contract aside on the mere ground of imbecility; but its existence affords a material ingredient in examining whether it has been obtained fraudulently or by undue influence. The same principle prevails in the Civil Law, and in the Scottish and other systems founded on it. [LUNACY.]

Imbibition (Lat. imbibo, *I drink in*). The absorption of a liquid into the pores of a solid. Much importance has been attributed to this property as belonging to the organic tissues and as affecting their functions.

Imbricated (Lat. imbricatus, from imbrex, *a tile*). In Botany, a term used in speaking of the arrangement of bodies, to denote that their parts lie over each other in regular order like the tiles upon the roof of a house, as, for example, the scales upon the cup of some acorns: also applied in speaking of the æstivation of petals or leaves, to denote that they overlap each other at the margin without any involution.

Imbroglio (a word borrowed from the Italian brogliare, *to confound or mix together*; whence the French brouiller and English embroil). In Literary language, the plot of a romance or a drama, when much perplexed and complicated, is said to be an *imbroglio.* The small burlesque theatrical pieces so termed by the Italians derive their ludicrous character from a similar species of absurdity.

Imides. Chemical compounds derived from ammonia by the replacement of two atoms of hydrogen by two of an organic radical. The basic imides being now generally termed *secondary amines*, the word is restricted to neutral derivatives.

Imitation (Lat. imitatio). In Music, a species of composition in which each part is made to imitate the others. Sometimes the motion or figure of the notes only is imitated, and frequently by a contrary motion, making what is called a *retrograde imitation*, or *imitazione canchenzante*. Imitation is subject to less strict form and rule than fugue.

Immaculate Conception of the Blessed Virgin. In Theology, an opinion in the church of Rome, erected by the present Pope, Pius IX., into an article of faith. The festival of the Conception of Mary is of great antiquity in the Western Church: certainly as old as the eighth century. But the question, whether the mother of our Saviour was free from the taint of original sin, can hardly be traced as the subject of discussion before the affirmative was strongly maintained, in 1301, by the Franciscan Duns Scotus. Eighty years later, certain persons of the Dominican order maintained the contrary proposition; and thus a question, hitherto left in respectful mystery, became the subject of strong controversy between the two most powerful orders in the church. The combatants were popularly designated as Scotists and Thomists. In 1483, Sixtus IV. took upon himself to declare the doctrine of the Franciscans not heretical; and in 1494 the university of Paris, which had always adhered to the doctrine of Scotus, compelled a preacher who defended the Thomist side to retract. The council of Trent, when affirming the doctrine of original sin, declared that it did not intend to comprehend therein the instance of the Blessed Virgin. Still the question was not formally decided; and several successive pontiffs in the seventeenth century thought fit to renew their prohibitions against either side, treating the supporters of the opposite doctrine as heretical. Thus Clement XI., having made a constitution for the observance of the feast 'Conceptionis B.M. Immaculatæ,' was highly displeased that the words of his bull were printed in an Italian city, in 1709, in the form 'Festum Immaculatæ Conceptionis B.V.,' thereby perverting it into a testimony in favour of the Franciscan tenet. But with the revival of ultramontane views and high doctrines of Roman Catholic theology which has marked the present century, arose the desire to have this long-pending controversy terminated in the sense esteemed most honourable to the exalted personage who was the subject of it.

Immemorial (Lat. in, neg., and memoria, *memory*). In English Law, a custom or prescription is said to be immemorial, when its existence is presumable from a period anterior to possible proof. This in English law was long ago arbitrarily fixed at A.D. 1189 (the commencement of the reign of Richard I.). It is therefore deemed that a custom is established at law when reasonable affirmative evidence of its antiquity is shown, and no instance to the contrary is proved to have taken place since that year; but customs or prescriptions may now be established in some cases by evidence of user for a much shorter period. [PRESCRIPTION.]

Immersion (Lat. immersio, from immergo, *I plunge under*). In Astronomy, denotes the disappearance of any celestial object behind another or in its shadow. Thus in an eclipse of one of Jupiter's satellites, the immersion takes place when the satellite disappears behind the body of the planet, or enters into the planet's shadow; and in an occultation of a planet or fixed star by the moon, the immersion is the disappearance of the star or planet behind the body of the moon. In like manner, the reappearance of the body is called its *emersion.* The immersions and emersions of fixed stars occulted by the moon, are phenomena of great importance for correcting the lunar tables.

Immersion, Baptism by. Seems to have been the most ancient mode adopted in the Christian church. The *trine* immersion, in honour of the three Persons of the Divinity, is mentioned by Tertullian, and prescribed in the *Sacramentary* of Gregory the Great; but *single*

immersion was held valid by that pope, and his decision was confirmed by the fourth council of Toledo, A. D. 633.

Immolation (Lat. immolatio). A ceremony used in the Roman sacrifices, which consisted of throwing upon the head of the victim some sort of corn or frankincense, together with the *mola*, or salt cake, and a little wine.

Immortality. [SOUL.]

Immortelles (Fr.). The 'Everlasting flowers' produced by various Composite plants, of which *Helichrysum* may be taken as the type. They include *Antennaria, Gnaphalium, Aphelexis, Phænocoma, Waitzia, Helipterum, Rhodanthe*, &c. The so-called flowers are the flower-heads surrounded by dry scarious coloured involucral scales, to which their beauty is due.

Immunity (Lat. immunitas). In Jurisprudence, freedom from any legal obligation. Thus the phrase *ecclesiastical immunities* comprehends all that portion of the rights of the church, in different countries, which consists in the freedom of its members, or of its property, from burdens thrown by law on other classes.

Impact (Lat. impactus, part. of impingo, *I strike against*). In Mechanics, the instantaneous action of two bodies, one or both being in motion, at the moment of their collision. When the bodies have no motion of rotation, the impact is said to be *direct* or *oblique* according as the common normal to the surfaces of the bodies at their *point of impact* does or does not coincide with the directions of their previous motions. The impact of spherical bodies, elastic and non-elastic, is considered in all elementary treatises on Mechanics. [COLLISION.]

Impages (Lat.). In Architecture, the border or framework which surrounds the panel of a door.

Impalement (Lat. palus, *a stake*). A species of punishment still (though rarely) in use among the Turks, and known to some barbarous nations, which consisted in thrusting a stake through the body, and thus leaving the victim to a lingering death. It is of great antiquity, being referred to in the *Eumenides* of Æschylus.

IMPALEMENT. In Heraldry, the division of a shield palewise, when the shield is said to be *party per pale*. *Impalement per baron et feme* is the division which takes place on marriage; when the husband's coat is borne on the dexter side of the pale, and the wife's on the sinister. Formerly, the husband's and wife's arms were impaled *by dimidiation*; that is, the dexter half of the husband's coat was impaled with the sinister half of the wife's: and this inconvenient mode of marshalling was pursued in French heraldry down to the period of the Revolution.

Impanation (from Lat. panis, *bread*). In Theology, the substantial union of the body and blood of Christ with the elements of the eucharist without a *change* in their nature. The word appears to be first used in the controversy about the real presence in the eleventh century, and to be applied, by the supporters of transubstantiation, to the less material doctrine of Berengarius and his followers. It has since been objected, by Roman Catholics, to the Lutheran theory, that it revived the old error of impanation. The supporters of the opinion of Berengarius were sometimes termed *Adessenarii*; from the word adesse, *to be present*.

Imparipinnate (Lat. impar, *odd*, and pinnatus, *winged*). In Botany, a term applied to pinnate leaves when there is a single terminal or odd leaflet, and not an even number of pairs.

Imparlance (Fr. parler, *to speak*). A mode of delaying proceedings in a civil action by petition to the court for further time. General imparlance was to the next term; special imparlance to a specified day, which might be in the same term. The practice of imparlance is now abolished (see stat. 2 Wm. IV. c. 39, and rule 31 of Trin. Term 1853), improved methods of procedure having been substituted.

Impastation. In Sculpture, the mixture of different matters bound together by means of cements capable of resisting the action of fire or air.

Impasto (Ital.). In Painting, a term applied to the substance or thickness of the colours as they are laid on the canvas; as thin, solid, heavy, &c.

Impatiens (Lat.). A very extensive genus of *Balsaminaceæ*, whose head-quarters are in India. One native species, *I. noli me tangere*, is called *Touch-me-not*, a name which alludes to a property possessed by the capsules of all the species, that of splitting up with elasticity into their component valves, if touched after they become ripe, the seeds being often scattered with violence: hence the generic name.

Impeachment (from the Latin impetere, *to prosecute*). A species of process against persons accused of treason, or high public crimes and misdemeanours of an inferior description. The first regular instances of this proceeding appear, according to Mr. Hatsell, on the rolls of parliament in the latter end of the reign of Edward III. Before that time the Lords seem to have exercised a high but irregular jurisdiction over state offences, at the prayer of the crown or of private persons. But in the case of Richard Lyon, 1376, we first find the Commons appearing in their public capacity as prosecutors: and several similar instances occur in the course of the following century. From the reign of Henry VI. to that of James I. impeachments seem to have fallen into disuse; bills of attainder, and prosecutions in the Star Chamber, having been employed in their stead. In the seventeenth year of James I. this form of proceeding was revived against Sir Giles Mompesson for having procured illegal patents, and from that time to the present has been the regular constitutional form of accusation for state offences. The form of the accusation exhibited by the Commons is styled *the articles of impeachment*. It is an undoubted right of the Commons to exhibit such articles against a peer for treason, or any

other high crimes and misdemeanours; but it has been doubted whether the Lords have jurisdiction in capital cases over a commoner in this proceeding. In one instance (in 1681) they refused to act, but have in several other instances admitted their competency. Managers are appointed by the Commons to conduct the prosecution before the Lords. In case of an impeachment of a peer for treason, it is usual to address the crown to appoint a lord high steward; but the appointment of such an officer does not seem essential to the conduct of an impeachment. By 12 and 13 Wm. III. c. 2 it is enacted that a pardon under the great seal shall not be pleadable to an impeachment. This, however, does not deprive the king of his prerogative of pardoning after conviction. It was determined, on the impeachment of Warren Hastings, that this proceeding in the Lords is not put an end to by the prorogation or dissolution of parliament; and an Act was passed to prevent prorogation or dissolution from having the effect of putting a stop to the previous proceedings in the House of Commons. Judgment on impeachment must proceed on the same evidence which would be required in the ordinary courts of justice; in which respect this proceeding differs from that by bill of attainder.

Impenetrability (Lat. impenetrabilis, *not to be penetrated*). In Physics, one of the essential properties of matter or body. It is a property inferred from invariable experience, and resting on this incontrovertible fact, that no two bodies can occupy the same portion of space in the same instant of time. Impenetrability, as respects solid bodies, requires no proof; it is obvious to the touch. With regard to liquids, the property may be proved by very simple experiments. Let a vessel be filled to the brim with water, and a solid incapable of solution in water be plunged into it; a portion of the water will overflow exactly equal in bulk to the body immersed. If a cork be rammed hard into the neck of a phial full of water, the phial will burst, while its neck remains entire. The disposition of air to resist penetration may be illustrated in the following way: Let a tall glass vessel be nearly filled with water, on the surface of which a lighted taper is set to float. If over this glass a smaller cylindrical vessel, likewise of glass, be inverted and pressed downwards, the contained air maintaining its place, the internal body of the water will descend, while the rest will rise up at the sides, and the taper will continue to burn for some seconds, encompassed by the whole mass of liquid. (Leslie's *Elements of Natural Philosophy.*)

Impennates, Impennes (Lat. in, and penna, *a wing*). The name of a tribe of swimming birds, having short wings covered with feathers resembling scales. The penguin (*Aptenodytes*) and the great Awk (*Alca impennis*) are examples of this group, which, however, is not a natural one.

Imperative Mood (Lat. impero, *I command*). That form of the verb which denotes command, entreaty, or, in general, desire. [GRAMMAR.]

Imperator. [EMPEROR.]

Imperatorin. A neutral crystalline principle contained in the root of *Imperatoria Ostruthium.*

Imperfect Cadence. In Music. [CADENCE.]

Imperfect Concords. In Music, such as are liable to change from major to minor, or the contrary, as are thirds and sixths; still, however, not losing their consonancy.

Imperfect Number. A number which is not equal to the sum of its divisors. [PERFECT, ABUNDANT, and DEFICIENT NUMBER.]

Imperfect Tense. In Grammar, that modification of a verb which expresses that the action or event of which we speak was, at a certain time to which we refer, in an unfinished state. This in English is designated by the auxiliary 'was,' joined with what is called the *present participle* but is really the locative case of a participial noun. In Greek it is formed by prefixing the temporal augment ε to the root of the verb. This augment is supposed by Bopp to be the same as the negative particle α, which is here simply a denial of *present* time. In Latin this tense is formed, like the future, by adding an affix from the root bhu, or bu (Gr. φυ), *to be.*

Imperial (Lat. imperialis). In Architecture, a species of dome, whose profile is pointed towards the top, and widens towards the base, thus forming a curve of contrary flexure; the domes executed in Persia present the most striking illustrations of this system; in them the stability is owing entirely to the adhesion of the cement employed in their construction.

IMPERIAL. A beverage formed by dissolving two drachms of cream of tartar in a pint of boiling water, and flavouring it, when cold, with lemon peel and sugar.

Impersonal Verbs. In Grammar, those used only in the third person; as the Greek ἔξεστι, Latin licet, *it is lawful.* It is quite clear that every verb, whether active or passive, must have a necessary reference to some noun, either expressed or understood, for its nominative; and hence the doctrine of impersonal verbs has been justly rejected by the best grammarians, both ancient and modern. [GRAMMAR.]

Impetigo (Lat.). An eruption of small pustules, sometimes called the *moist tetter.* Something of this kind is often produced by particular trades, where irritating substances are applied to the skin. Cleanliness, cooling ointments, and occasionally the nitrated mercurial ointment much diluted, are useful. Harrogate water and baths have been recommended, and mild aperients. The eruption is not contagious.

Impetus (Lat. *force*). In Gunnery, the altitude through which a heavy body must fall to acquire a velocity equal to that with which the ball is discharged from the piece.

Impetus. In Mechanics, the same with *momentum* or *force*.

Implication (Lat. implicatio, *an intanglement*). In Law, an inference necessarily arising from something declared. Thus contracts are said to be either express or implied. [CONTRACT.]

Implicit Function. [EXPLICIT FUNCTION.]

Impluvium (Lat.). In ancient Architecture, the outer part of the court of a house which was exposed to the weather. In the summer time, it was the custom of the Romans to stretch an awning over this part of their habitations.

Imponderable Substances. Heat, light, electricity, and magnetism are so called, by those who refer their phenomena to the presence of very subtile forms of matter of inappreciable weight.

Imports (Lat. importo, *I bring in*). The mass of commodities purchased from foreign countries, and employed either for manufacture, with a view to subsequent exportation and home use, or for immediate consumption, are called the *imports* of a country.

The declared value of each among thirty-two heads of imports, purchased by the United Kingdom in the year 1863, exceeded a million sterling. Of these quantities, the most valuable were cotton, reckoned at fifty-six millions; corn, including rice, at nearly twenty-nine millions; wool at nearly twelve millions; sugar at eleven millions and a half; tea at ten millions and a half; raw and thrown silk at nine millions and a half; timber at five millions and a half; coffee, wine, butter, and flax, each at about four millions and a halt.

In ordinary years the largest amount (in value) of imports has been derived from the United States. Since 1861, however, British India has headed the list. Still the United States take the second place, France ranks next, then Egypt, China, Russia, the West India Islands, the North American colonies, Holland, Australia, the Hanse Towns, Prussia, Turkey, Belgium; the imports from each of these countries (stated in the order of the quantity supplied by each) exceeding five millions.

The following is the value of imports since 1854, the year in which the real value was first estimated:—

Year	£	Year	£
1854.	152,389,053.	1860.	210,530,873.
1855.	143,542,850.	1861.	217,485,024.
1856.	172,544,154.	1862.	225,716,976.
1857.	187,844,441.	1863.	248,980,942.
1858.	164,583,832.	1864.	267,375,333.
1859.	179,182,355.		

Imposing (Fr. imposer). In Printing, the arrangement of the pages of a sheet, or form, upon the imposing stone in their proper order, so that when they are printed and the sheet folded they will follow each other consecutively. The furniture is then put about them, with the chase; and they are wedged up with quoins, so as to be ready for the pressman.

Imposition of Hands. This ceremony is maintained in the English and other churches, as being conformable to the apostolic practice and that of the earliest ages, in which confirmation and the ordination of priests and deacons are supposed to have been accompanied with the performance of this ceremony. In Acts vi. the apostles are represented as laying their hands on those appointed to be deacons; in Acts viii. and xix. the converts who had been already baptised by Philip and John are in the same manner confirmed by Paul and the other apostles.

Impossible Quantity. In Algebra, the symbolical result of an impossible operation. The term is usually restricted to quantities expressible only in the form $a + b\sqrt{-1}$, where a and b denote real numbers. If $-$ were the symbol of ordinary subtraction, however, and b denoted a greater number than a, the term *impossible* might, with equal propriety, be applied to the quantity $a - b$. [IMAGINARY.]

Impost (Lat. impositus, part. of impono, *I place upon*): In Architecture, the capital of a pier, or pilaster, that receives the thrust of an arch. The impost varies in the character of its mouldings with the order to which it is applied. Sometimes the whole of the entablature serves as an *impost* to an arch. The term is applicable to any supporting, or springing, piece.

The term *impost* is also frequently used as synonymous with a tax or public burden.

Imprecation (Lat. imprecatio). In Rhetoric and Poetry, a form of speech in which the superior powers are invoked to destroy or injure the objects of the speaker's enmity. In Shakspeare, Lear's imprecation against his daughters, and that of Timon against the Athenians, furnish noble instances.

Impregnation (Lat. prægnans, *pregnant*). In Botany, the act of the fertilisation of the ovules by means of the pollen tubes. It is equivalent to *fertilisation*.

Imprescriptible Rights. In Law, rights which cannot be lost to the owner through the claims of any other founded on PRESCRIPTION [which see].

Impressment. The forcible levying of mariners in time of war for the king's service at sea. The power of impressment is a branch of the king's prerogative. It is mentioned in the statute 2 Richard II. c. 4, as a recognised usage. Various classes of mariners are exempted from it by particular statutes. The officer impressing acted under an impress warrant for that especial purpose; but the regularity of this instrument was carefully watched by the courts, and criminal informations have been also granted against officers guilty of unnecessary severity or acts of private malice in carrying it into execution. It was wholly disused in the Russian war of 1854.

Imprimatur (Lat. *let it be printed*). The term applied to the privilege which, in countries subjected to the censorship of the press,

must be granted by a public functionary appointed for the purpose before any book can be printed. This formula was much used in English books printed in the sixteenth and seventeenth centuries, and was usually printed so as to face the title-page. This permission is still vested in some of our own universities, especially in Scotland, where it is not unusual to find on the title-page of some works recommended to public favour by the senatus academicus, the *imprimatur* of the principal. Unlicensed books and reprints were sometimes printed in places called by Moxon *holes*, or *holes private*.

Imprint (Fr. imprimer). The designation of the place where, by whom, and when a book is printed or published, always placed at the bottom of the title. Among the early printers it was inserted at the end of the book, and is styled the *colophon*. By the Act 39 Geo. III. c. 79, every printer was obliged to affix his name and residence to each article printed, and if it consisted of more than one leaf, then upon the first and last leaves, under a heavy penalty; but there were some exceptions. The Act 39 Geo. III. c. 79 was amended by 51 Geo. III. c. 65 and 2 & 3 Vict. c. 12. No prosecution can now be entered into for omitting an imprint without the consent of the law officers of the crown, and they will not interfere unless the work is of a violent political or treasonable character. But it has been recently decided in the superior courts that a printer cannot recover his charges unless his imprint appears on his work. The author, the printer, and the publisher of a libel are all liable to an action for damages at the suit of the injured party, to an indictment, or in certain cases to a criminal information.

Impromptu (from the Latin phrase, in promptu esse, *to be in readiness*). In Literature, any short and pointed production supposed to be brought forth on the spur of the moment; generally of an epigrammatic character.

Improper Fraction. In Arithmetic, one whose numerator exceeds its denominator: it consists of a whole number and a *proper fraction*. Thus the improper fraction $\frac{5}{2}$ is equal to $2 + \frac{1}{2}$, which latter, written in the form $2\frac{1}{2}$, is called a *mixed number*. In Algebra, a fraction whose numerator and denominator are rational functions of the same variable, is said to be proper or improper, according as the *degree* of the function in the denominator does or does not exceed that in the numerator.

Impropriation (Lat. proprius, *peculiar*). In Law, where the tithes, glebe, or other ecclesiastical dues of a parish are in the hands of a layman. The religious societies having, at the time of the Reformation, the property of many benefices in their hands, clauses were inserted in the acts by which they were dissolved to give that property absolutely to the king, by whom it was granted out to lay proprietors. In common language, such benefices are said to be *impropriated* as are in the hands of laymen; such as are held by spiritual corporations, sole or aggregate, are termed *appropriated*.

Improvisatore (from Lat. improviso, *on a sudden, unexpectedly*). An Italian word, signifying a person who has the talent of composing and reciting verses on a given subject immediately and without premeditation. This peculiar talent, thus restricted, appears to belong, almost exclusively, to the Italian language and people. Much, no doubt, of the facility of these improvisatori, which appears almost preternatural to one unaccustomed to hear them, arises from the peculiar ease and flexibility of their language, and its richness in rhymes. But this circumstance will not wholly account for so singular a national faculty; for, about the time of the revival of letters, Italy possessed improvisatori in Latin as well as in Italian. Many poets have enjoyed considerable celebrity in their day from their success in this mode of composition; but we are not aware that any of their poems have acquired a permanent celebrity, although often taken down from their recitation. Tuscany and the Venetian States have been most famous for the production of improvisatori, especially Sienna and Verona; in which latter city the talent seems to have been perpetuated by succession. The chevalier Bernardino Perfetti, the most famous of all these reciters, was of Sienna: he flourished in the first half of the seventeenth century. He is said to have possessed unbounded erudition, and to have been able to pour forth extempore poetical essays on the most abstruse questions of science. There have been many distinguished females possessed of this talent (improvisatrici). Corilla, the most celebrated of them, was of Pistoja in Tuscany. She was the original of Madame de Staël's *Corinne*. She received in 1776 the laureate crown at Rome, an honour which had also been accorded to Perfetti. Germany is said to have produced one noted improvisatrice, Anna Louisa Karsch. There appears no reason why the term *improvisation* should not also be applied to the delivery of unpremeditated discourses in prose. It is the exertion of a very similar faculty, perfected in the same manner by habit to a degree almost inconceivable by those not accustomed to witness its exercise. It is, however, much more general. The North American Indians are represented to possess it in a high degree. In Europe, it is most generally to be found in the pulpit. Public secular oratory of this unpremeditated description is far more common in England and the United States, and the power much more sedulously cultivated, than in the continental countries of Europe. (Forsyth's *Italy*; *Edinburgh Review* vol. xxii.; *Encyclopædia Metropolitana*.)

In Antis (Lat.). A building is said to be *in antis* when it has upon the façade two columns, detached, standing between two antæ that terminate the side walls of the building; as in the temples at Rhamnus and Sunium.

In Cœna Domini (Lat. *at the Lord's Supper*). The name of a celebrated papal bull, containing a collection of extracts from different constitutions of the popes, comprising those rights which, since the time of Gregory VII., have been uninterruptedly claimed by the Roman see, and a proclamation of anathema against all who violate them. It was annually read on Holy Thursday, whence it receives its name; but lately on Easter Monday. The sects of heretics are cursed in it by their several designations. A copy of the bull is hung up at the churches of St. Peter and St. John Lateran; and all patriarchs, primates, bishops, &c., are required to have it read once or more annually in their churches.

In Esse (Lat.). A term applied to things actually existing. A difference is made by authors between *in esse* and *in posse*: the latter being applied to things that are not, but may be; the former being said of things actually apparent and visible.

In Formâ Pauperis (Lat.). In Law, a person is said to sue as a pauper, or *in formâ pauperis*, when he takes advantage of the stat. 11 Hen. VII. c. 12, swearing himself not to be worth five pounds; in which case he is entitled to have any necessary writs or process gratis, and attorney and counsel assigned him without fee, and is excused from paying costs when plaintiff. By misconduct, and under certain other circumstances, the party is dispaupered, and loses his privilege. He is capable of recovering costs, although not liable.

Inarching. In Horticulture, grafting by approach, that is to say uniting a scion to a stock without severing its connection with the parent until it has become united to the stock; the branches being brought together in an arching manner.

Inauguration (Lat. inauguratio). This term was originally applied to the Roman ceremony by which the augurs consecrated any person or thing to the service of the gods: it is now improperly used in a sense nearly synonymous with the *consecration* of a prelate, or the *coronation* of a king or emperor, and is even employed to denote an introduction to any office with certain ceremonies, or the commencement of any undertaking.

Inca or **Ynca.** A name given by the Indians of ancient Peru to their kings and princes of the blood. The empire of the Incas, founded, according to tradition, by Manco Capac, extended over the table-land of the Andes, from Pasto to the neighbourhood of Chili, as well as the lowlands on the coast. It was destroyed by the Spaniards under Pizarro and Almagro. The blood royal of the Incas is preserved, or believed to be so, among the Indians of the present day; and Tupac Amaru, who carried on a long and nearly successful insurrection against Spain in the latter part of the last century, professed to be descended from them.

Incandescence (Lat. in, and candere, *to be warm*). The luminosity exhibited by a substance when heated up to a certain point.

Incantation (Lat. incantatio, from in, and canto, *I sing*). A form of words combined with certain ceremonies for superstitious purposes. They were most commonly resorted to by unsuccessful lovers. [PHILTER.]

Incarceration (Lat. in, and carcer, *a prison*). Literally, imprisonment. In Surgery, this term is generally applied to ruptures or herniæ, with the same meaning as *strangulation*; but, according to Scarpa, an *incarcerated* hernia is that in which the course of the intestinal matter is interrupted without any considerable injury of the bowel itself; whereas in *strangulated* hernia the vitality of the bowel is affected, or there is organic injury of its coats. The functions of the merely incarcerated intestine are healthily resumed upon its return into the abdomen, which is not the case where true strangulation has taken place.

Incarnation (Lat. caro, carnis, *flesh*). A word in common use among theologians to express the union of the Godhead with the Manhood in Jesus Christ. For the opinions of the Arians, Eutychians, Nestorians, Sabellians, and Socinians on this subject, see the respective articles.

Incendiary (Lat. incendiarius, from incendo, *I burn*). Literally, one who sets fire wilfully to a building or stores; but it is used also in a metaphorical sense for any political agitator who seeks to inflame the minds of the people. [ARSON.]

Incendiary Letter. In Law, a common, though not strictly a legal phrase, especially in Scotland, for threatening letters, meaning not only the burning of property, but murder or other mischiefs.

Incense. [FRANKINCENSE.]

Incense-tree or **Incense-wood.** Names implying the use to which the resinous wood and juice of some species of *Icica*, especially *I. guianensis* and *I. heterophylla*, are applied.

Inceptive (Lat. incipio, *I begin*). A word used by Dr. Wallis to express such *moments* or first principles as, though possessed of no magnitude themselves, have yet the power of producing it by being extended or enlarged. Thus a point or a line, though the former has no proper magnitude and the latter no breadth, are both said to be *inceptive* of enlargement.

In the Latin language *inceptive* or *inchoative* verbs (the latter term being derived from the Lat. inchoare, *to begin*) are those which, according to grammarians, are characterised by the termination *sco* or *scor* added to their primitives, to express the augmentation of the qualities indicated by the words from which they are derived: as *augere*, to increase; *augescere*, to begin to increase; *pallere*, to be pale; *pallescere*, to grow pale.

Incertum Opus (Lat. *uncertain work*).

In ancient Architecture, a species of walling whose face exhibits an irregularly formed masonry not laid in horizontal courses, or in regular dimensions.

Inch. A measure of length; the twelfth part of a foot.

INCH. A word used as a prefix to certain small Scottish islands, as Inch-Keith, Inch-Garvie. It is derived from the old Irish or Gaelic word INIS [which see].

Incidence (Lat. incido, *I fall upon*). The meeting of one body with another. The term *angle of incidence* is used by writers on Mechanics and Optics in different senses. Thus, in the case of a body striking against a plane, the angle of incidence is by some understood to signify the angle formed by the line in which the body moved with a straight line perpendicular to the plane; while others use the term to denote the angle which the line of incidence makes with the plane itself. When light or any elastic body is reflected from a surface, the angle of incidence is equal to the angle of reflection; and in the case of refraction, the sine of the angle of incidence has to the sine of the angle of refraction a constant ratio for the same media.

Incident. In Law, something necessarily appertaining to and depending on another, which is termed the *principal*.

Incineration (Lat. in, and cinis, cineres, *ashes*). The combustion of organic substances for the purpose of obtaining their ashes or incombustible residue.

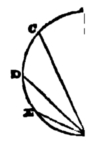
Incisors (Lat. incido, *I cut*). The teeth implanted in the premaxillary bones of the upper jaw and in the corresponding place in the lower jaw, and generally shaped for the purpose of cutting or coarsely dividing the food.

Inclination (Lat. inclinatio). A term of frequent occurrence in Geometry and Physics. Euclid makes use of the term in order to define an angle; a more satisfactory way, perhaps, would be the precisely opposite one of regarding inclination as synonymous with angle, the latter being defined as a *quantity of turning* or *rotation*. [ANGLE.]

INCLINATION. In Astronomy, the planes in which the planets revolve round the sun are *inclined* at different angles to the plane of the ecliptic. Again, the axes of rotation of the planets are *inclined* to the planes in which they revolve. The measure of these angles is called the *inclination*.

Inclined Plane. One of the five simple mechanical powers. The theory of the inclined plane is at once deduced from the decomposition of forces. The weight of a body resting on such a plane, the pressure which it exerts, perpendicularly, on the plane, and the force which must be applied parallel to the plane in order to prevent its descent, are respectively proportional to the length, the base, and the height of the plane.

There are two properties connected with the motion of bodies on inclined planes which may be here noticed. The first is, that the velocity acquired by a body in descending from any altitude to a horizontal plane is the same when it reaches the horizontal plane, whether it has been allowed to fall freely in the vertical, or been constrained to move along an inclined plane at any angle of elevation. The second is, that the times of descent through all chords of the same circle to the lowest point are equal, and equal to the time which the body would take to fall through a height equal to the diameter of the circle. Thus, let A B be the diameter, and C B, D B, and E B chords of a circle; the time which a heavy body would require to fall vertically through the diameter is the same as that which it would require to roll down the inclined plane C B, or D B, or E B. In other words, bodies placed at A, C, D, and E, and abandoned at the same instant to the action of gravity, would arrive at B at the same time. In these propositions it is supposed, of course, that there is no resistance from friction.



Inclinometer. An apparatus for determining the vertical element of the magnetic force. The difficulty of determining this element by a direct method is considerable, on account of the delicacy of the apparatus which is requisite. Various indirect methods have been proposed. Dr. Lloyd, in the *Account of the Magnetical Observatory at Dublin*, describes an Inductive Inclinometer, 'the principle of which is the measurement of the intensity induced on a vertical bar of soft iron by the deviation it is capable of causing in a horizontal bar suspended near it.' Weber, of Göttingen, proposed a method, in which 'the deflection of the horizontal magnet is produced by the earth's magnetism, induced not on a vertical bar of soft iron at rest, but on a ring, sphere, or plate of copper made to revolve about a vertical axis.' Dr. Lamont, of Munich, proposed a third and less simple method: 'As in Dr. Lloyd's process, a bar of soft iron is used as a temporary magnet. The bar so temporarily magnetised is made to act unequally on the two bars of an astatic magnetic couple, thereby tending to draw them aside from a given position in which they would otherwise be held by a fixed magnet of a given power. This tendency is, however, destroyed by another magnet placed in a given position at a given distance. A series of reversals and changes of distance in the soft iron bar and the neutralising bar is then operated, which furnishes equations by means of which every quantity excepting the intensity sought and known quantities can be eliminated.' (*British Association Report*, 1842.) [MAGNETOMETER.]

Inclosure (Lat. includo, *I shut up*). This term, in a general sense, is one of the first acts of appropriation, since in a new country when any portion of land is purchased, or taken possession of, it is inclosed; that is, surrounded by a boundary line, indicated by certain ob-

jects, natural or artificial, or of both kinds. In a particular sense, to inclose land is to divide it into fields, and surround these by fences, in order that each field may be devoted to a particular description of culture. If nothing further than the cultivation of plants of different kinds were carried on in the fields of a farm, their subdivision by fences would be altogether unnecessary; but as in most cases fields are kept alternately under tillage and pasture, it is desirable to have fences to confine the pasturing animals to the field appropriated for their use.

In Law, the inclosure of common or waste land, on which the rights of commoners subsist, is effected in England through Acts of Parliament, either special or general, by the instrumentality of commissioners appointed under those Acts. The last general inclosure Act is 8 & 9 Vict. c. 118, amended by subsequent Acts.

Inclusa (Lat. inclusus, part. of includo, *I inclose*). The name of a tribe of shell-bearing Acephalous Molluscs in the system of Cuvier, characterised by the closed state of the mantle, which everywhere surrounds and envelopes the body, leaving only a narrow aperture for the passage of the foot, and being prolonged posteriorly into two siphons projecting beyond the shell, which is always open at its two extremities. The bivalves of this family are remarkable for their powers of burrowing and excavating clay, sand, wood, or even stony rocks; and many of the genera secrete, in addition to the ordinary valves, a calcareous lining to their burrows, which forms a tube surrounding the valves themselves. The relative proportions of the tube and valves well illustrate the so-called law of the *balance of organs*, the valves becoming diminished in size as the external sheath is more developed. In the ship-borer (*Teredo navalis*), which has the longest tube, the valves are of the smallest size, being reduced to the office of mere boring instruments, instead of serving to protect the soft parts of the animal. In the watering-pot shell (*Aspergillum*, Lam.) they cease to be movable organs, and are blended or confluent with the external tube; this is dilated at the anterior extremity, which is surrounded with a projecting radiated ridge, and closed by a convex plate perforated like the mouth of a watering-pot.

Inclusi or **Reclusi** (Lat. *shut up*). In Ecclesiastical History, a class of religious persons who lived as hermits in single cells, generally attached to monasteries, sometimes in the neighbourhood of villages and towns, under the law of not leaving them unless in case of extreme necessity and with the approbation of the bishop, whose seal, or that of the abbot, was impressed on its door. The cells are said to have been commonly twelve feet in length and breadth. Nuns became sometimes, but more rarely, recluses.

Incognito (Ital. *unknown*). This word, abbreviated into *incog.*, denotes the disguise resorted to by the great when they are unwilling to be recognised. It consists either in assuming a different name or title for the nonce, or in travelling from one place to another without a retinue or other marks of distinction.

Incombustible Cloth (Lat. combustio, *a burning*). This term was originally applied to cloth with which asbestus was interwoven; on burning away the fibre, the incombustible mineral texture remained.

More recently, cloth and other materials have been rendered to a great extent incombustible by impregnating them with certain saline substances, which, upon the application of fire, form a species of glass upon the goods, and prevent them burning with flame by protecting them from the necessary access of air. [COMBUSTION.] Borax, alum, and phosphate of soda, or ammonia are the most effectual salts for this purpose; and by properly applying them, with starch, if to muslin dresses, curtains, or bed furniture, or with size to paper hangings and scenery, these several articles may be rendered incapable of burning with flame, and thus serious accidents by fire prevented. Wood may also be rendered comparatively incombustible, by soaking it in solutions of the above salts. [ASBESTUS.]

Income. In Finance, the annual produce of taxation and other sources of public revenue, the object of which is to defray the charges of administration, of defence, of justice, and of public credit.

Some of the annual charges to which the nation is liable, are fixed, as, for example, the interest on the funded debt, the civil list, and some few similar liabilities. Others are variable, as the charge of the army and navy, and the interest on the floating debt. On the latter subjects votes in detail are taken every year, and, when parliament is pledged to supply, the administration, through the Chancellor of the Exchequer, announces its budget of taxes for the forthcoming financial year. Unless something unforeseen occurs, the precision with which the Chancellor of the Exchequer anticipates the revenue derivable from the taxes imposed, is the measure of that official's intelligence and capacity. In general it is the practice to include a slight estimated surplus in the aggregate of the year's taxation. All excess of income over expenditure is devoted to the extinction of a part of the public debt.

In the following table it will be observed that the charge of collecting the revenue is not included in the first eight years, but is so included afterwards. It should be remembered, also, that in all inferences from public expenditure in the United Kingdom as contrasted with that of other countries, a large and variable amount of taxation for poor rates, county rates, &c. is not included in the general account of public charges, though analogous taxation does exist and is included generally in the fiscal arrangements of continental countries.

Total Amount of the Estimated and Actual Revenue and Expenditure of the United Kingdom, with the Difference between the Estimated and Actual Amounts, and the Surplus or Deficiency of Income.

(In this Table, in accordance with the system upon which the Budget Estimates have been framed, the years ended April 5 are given from 1849 to 1854, and the figures for the Revenue and Expenditure show the Net amounts up to the year ended March 31, 1856, and the Gross amounts after that Period.)

Years ended	Revenue: Estimated in the Budgets	Revenue: Actual Receipts at the Exchequer	Revenue: More (+) or less (—) than Budget	Expenditure: Estimated in the Budgets	Expenditure: Actual Payments out of the Exchequer	Expenditure: More (+) or less (—) than Budget	Surplus (+) or Deficiency (—) of Income	Years ended
	NET AMOUNTS. (*Exclusive* of Charges for Collection of Revenue, &c.)							
	£	£	£	£	£	£	£	
April 5, 1849	52,130,000	53,017,733	+ 887,733	54,161,256	53,287,111	− 874,145	− 269,378	*April* 5, 1849
„ 1850	52,262,000	52,916,919	+ 654,919	52,157,696	50,378,417	−1,779,279	+ 2,538,502	„ 1850
„ 1851	51,535,000	53,057,053	+1,522,053	50,763,582	49,882,322	− 881,260	+ 3,174,731	„ 1851
„ 1852	51,172,000	52,468,319	+1,296,319	50,247,171	50,291,323	+ 44,152	+ 2,176,996	„ 1852
„ 1853	51,625,000	53,243,218	+1,618,218	51,164,000	50,782,476	− 381,524	+ 2,460,742	„ 1853
„ 1854	52,578,000	54,774,905	+2,196,905	52,083,000	51,250,120	− 832,880	+ 3,524,785	„ 1854
Mar. 31, 1855	59,496,000	59,496,154	+ 154	63,039,000	65,692,962	+2,653,962	− 6,196,808	Mar. 31, 1855
„ 1856	67,139,000	65,704,491	−1,434,509	*86,034,000	*88,428,345	+2,394,345	−22,723,854	„ 1856
	GROSS AMOUNTS. (*Including* Charges for Collection of Revenue, &c.)							
„ 1857	71,740,000	72,334,862	+ 594,862	81,113,000	75,588,667	−5,524,333	− 3,254,605	„ 1857
„ 1858	66,365,000	67,881,513	+1,516,513	65,434,000	68,128,859	+2,694,859	− 247,346	„ 1858
„ 1859	63,920,000	65,477,284	+1,557,284	63,610,000	64,663,882	+1,053,882	+ 813,402	„ 1859
„ 1860	69,460,000	71,089,669	+1,629,669	69,207,000	†69,502,289	+ 295,289	+ 1,587,380	„ 1860
„ 1861	72,248,000	70,283,674	−1,964,326	73,534,000	‡72,792,059	− 741,941	− 2,508,385	„ 1861
„ 1862	70,283,000	69,674,479	− 608,521	§69,875,000	‡71,116,485	+1,241,485	− 1,442,006	„ 1862
„ 1863	‖70,050,000	70,603,561	+ 553,561	70,108,000	‡69,302,008	− 805,992	+ 1,301,553	„ 1863
„ 1864	68,171,000	70,208,964	+2,037,964	¶68,283,000	‡67,056,286	−1,226,714	+ 3,152,678	„ 1864

* 1855–56.—Excluding 1,000,000*l.* to pay off Ways and Means Bills issued in 1854–5.
† 1859–60.—Including 858,057*l.* for Operations in China, not provided for in the Budget Estimate.
‡ Exclusive of Expenditure for Fortifications, provided for by creation of Annuities, and not estimated in the Budgets.
§ 1861–62.—Exclusive of a Supplementary Estimate presented in 1862 on account of the Expedition to Canada.
‖ 1862–63.—After deducting 140,000*l.* for the drawback upon Hops.
¶ Including 585,000*l.* of Supplementary Estimates.

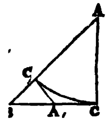
Income. In Political Economy, the aggregate value of all material products derived from the labour of a nation in any one year, constitutes its income, after deductions for the replacement of such capital as is expended in the process of production.

Many calculations have been made as to the amount of national income, but most of these err in the fact that they are estimated from such personal incomes as form the object of direct taxation, added to those which fall below it. But it will be clear that all personal income which is derived without the expenditure of labour on the part of the recipient, is in effect, values being consequent on labour only, a deduction from the fruits of labour itself, or from the capacity of expenditure which the labourer would otherwise possess. The rent of land, the dividends on public debt, interest paid by private individuals on loan or mortgage, with all payments made for administration, protection and instruction, and all taxes which are imposed on the public for other purposes, are not to be reckoned in national income along with the products of labour, but are only suggestive of what that income is. In other words, the aggregate of private incomes is largely in excess of the amount of national income, because a large portion of every private income is charged with the maintenance of other private incomes. The service rendered by the recipients of such incomes may be of the highest importance, both to the community at large and to parties who make the payments; but they must be in the estimate of gross income looked on as part of the expense of the process of production, or the same value will be reckoned twice or even many times over in the calculation.

Income-tax. [Taxation.]

Incommensurable (Lat. in, neg., con = cum, *with*, and mensurabilis, *measurable*). Two or more quantities of the same kind are said to be incommensurable when no other like quantity is exactly contained in both. Two incommensurable quantities, therefore, can never be proportional to two numbers or even to two fractions; since the latter, after reduction to a common denominator, are proportional to their numerators, and any two numbers whatever have unity for their common measure. Hence arises the necessarily imperfect character of all algebraical demonstrations of geometrical theorems involving the proportionality of lines, areas, or volumes, and hence also the need of Euclid's fifth and perhaps most perfect book. Two lines chosen at random will *in general* be incommensurable, in other words the probability of

their being commensurable is exceedingly small; and in attempting to represent these lines by numbers, the utmost we can do is to assign two numbers which shall be *as nearly as we please* proportional to the lines. The diagonal and side of a square, for instance, cannot be exactly represented by any two numbers whatever; for, as Euclid has proved in his tenth book, they are incommensurable.



In fact, if A B C be half a square, $C C_1$ a circular arc described around A as centre, and $C_1 A_1$ a tangent to this arc at C_1, it can easily be shown that $B C_1 = C_1 A_1 = A_1 C$, so that $A_1 B C_1$ is itself half a smaller square. Now if A B and A C had a common measure, the latter would also be a common measure of $B C = A C$ and of $B C_1 = A B - B C$, and hence also a common measure of $B C_1$ and $A_1 B = B C - B C_1$. [COMMENSURABLE.] Hence the diagonal and side of the first square can have no common measure which is not also a common measure of the diagonal and side of the smaller square, as well as of the diagonal and side of a third and still smaller square obtained from the second in the same manner as the second was obtained from the first; and so on. The construction being manifestly endless, we conclude that the diagonal and side of the original square can have no common measure which is not also a common measure of the diagonal and side of the least square of the series; in other words, they have no common measure whatever.

Incompatibles (Lat. in, neg., con = cum, and patior, *I endure*). In Chemistry, salts and other substances are said to be *incompatible* which cannot exist together in solution without mutual decomposition. Thus the soluble salts of lead and of baryta are incompatible with sulphuric acid and the sulphates, because the sulphates of lead and of baryta are insoluble, and consequently thrown down in the form of precipitates.

Incompressibility (Lat. in, neg., con = cum, and premo, pressi, *I press*). That quality of bodies in virtue of which their volumes cannot be diminished. There are no substances, perhaps, absolutely incompressible. Liquids, however, resist compression with great force; but the experiments of Oersted, Perkins, and Canton have proved that water has its bulk sensibly diminished by increasing the pressure upon it. Nevertheless, the extent to which the compression can be carried is very small. On enclosing water within an iron cannon, the sides of which were three inches in thickness, and applying a very great force of pressure, the cannon burst before the volume of water had been reduced to 19-20ths of its original dimensions. A pressure equal to that of the atmosphere reduces the bulk of water only about forty-five parts in one million.

Incongruous (Lat. incongruus, *inconsistent*). In the theory of numbers, two numbers are said to be incongruous with respect to a given *modulus*, or third number, when the difference between those two numbers is not divisible by the modulus. Thus 15 and 3 are incongruous with respect to the modulus 7, but congruous with respect to the modulus 4. The *incongruous roots* of a congruence are the incongruous numbers which satisfy that congruence. Thus 8 and 16 are incongruous roots of $x^4 \equiv 1$ (mod. 5). [CONGRUENCE.]

Incorporation (Lat. in, and corpus, *a body*). In Law, the formation of a legally constituted body with perpetual succession and corporate rights. [CORPORATION.]

Incrassate (Lat. incrassatus, *rendered thick*). In Botany, applied to bodies which are thicker than usual in proportion to their area, as in the leaves of succulents.

Increment, Decrement (Lat. incrementum and decrementum, *increase* and *decrease*). In Mathematics, the difference between two successive values of a variable quantity is called an *increment* or a *decrement* accordingly as the second value is greater or less than the first. A decrement being considered as a *negative increment*, we speak generally of the increment of a function which corresponds to a given increment of its independent variable. The determination and investigation of the ratio of two such increments is the primary object of contemplation in the *calculus of differences*, whilst the *differential calculus* is concerned chiefly with the *limit* to which this ratio approaches as the increments continually diminish. The *method of increments* was the name originally given to the calculus of differences by Dr. Brook Taylor, whose *Methodus Incrementorum*, published in 1715, contains the celebrated theorem which has since been made the basis of the differential calculus.

INCREMENT. In Rhetoric, a species of climax rising gradually from the lowest to the highest. [CLIMAX.]

Incrustation (Lat. incrustatio). In Architecture and Sculpture, a work fixed with cement, or cramp irons, into notches made to receive it; such as inlaid work, mosaics, &c.

Incubation (Lat. incubatio, *a brooding*). Hatching, or the lying down of an animal upon her own or another's eggs, communicating to them, and maintaining them at, her own temperature: a condition essential to their developement. In many animals the developement of the fœtus takes place after the exclusion of the egg, and whilst it is maintained in contact with the external surface of the parent's body, as in the crab and lobster tribes, beneath the caudal plates; or agglutinated to the surface of the abdomen, as in certain species of pipe-fish (*Syngnathus*); or concealed in cutaneous marsupial cavities, as in other species of *Syngnathus*, and the *Hippocampus*; but in these and other instances from the cold-blooded animals, the protection of the ova seems to be the object of their attachment to the parent, and not the communication of warmth or any other influence essential to their developement. It is only in the Oviparous class with warm blood, or birds, that true incubation takes place, and in this

class with the sole exception of the Megapodes or *Mound-birds*. Another characteristic of true incubation is that the place of the eggs determines that of the incubator, which can only perform its office *by lying down upon the eggs*; while in most of the examples of false incubation in the cold-blooded animals, the eggs are retained by special contrivances in contact with the parent, without occasioning any restraint upon her postures or movements.

That a due degree of warmth is the essential object of incubation in birds, is proved by the ancient and well-known practice of substituting artificial heat, by which fertile eggs are hatched in the same period, and the excluded chick is as fully and strongly developed as when produced by natural incubation.

The mean temperature of incubation is 100° Fahr.; it may vary from 95° to 105°, and towards the close of the process may be suspended for one or two hours, or for a longer period, according to the degree of extraneous heat which the eggs may derive from their situation, without fatal consequences to the embryo.

The power of communicating the requisite degree of warmth to their eggs arises in birds out of the unusual developement of, and determination of blood to, a peculiar plexus of vessels distributed over the skin of the abdomen, and which, in most birds, is connected with a derivation of blood from the internal organs of generation, after the subsidence of the functional activity of the ovarium and oviduct, to the external integuments. The vascular, hot, and sensitive condition of the skin of the abdomen is the exciting cause of that uncontrollable propensity to incubate which the Greeks denominated *storge*, and which, with its associated phenomena of patience, abstinence, and self-denial, forms so remarkable a feature in the economy of birds. The egg of the bird presents several peculiarities in relation to the circumstances under which it is to be developed: its oval form permits a greater proportion of its surface to be in contact with the heat-communicating skin of the parent than if it had been a spherical body; while the shell, by virtue of its hard calcareous texture, and its arched disposition about the soft contents, sufficiently defends them from the superincumbent pressure. As warmth is the only essential influence which the egg derives from the parent, the shell is porous, and permeable to air, and the germ is surrounded by an adequate store of nutritious matter. This matter is of two kinds: the external, called the white of the egg, or albumen, which wholly disappears during the process of incubation; and the internal part, or yolk, inclosed in a peculiar membrane, and rendered lighter and of an orange colour by the admixture of a peculiar oil. The germ is situated at the superficies of the yolk, beneath the vitelline membrane, in the circular opaque white spot called the *cicatricula*, or *tread*; and a peculiar mechanism is superadded to the yolk, by means of which the germ-bearing surface of the yolk is always kept uppermost, and next to the warmest surface of the egg, and at the same time is relieved from the pressure against the hard shell, to which it must have been subject if the light yolk had not been restrained from rising to absolute contact with that surface. Both these purposes are effected by the attachment of two cords of condensed albumen, continued at one end from near the poles of the yolk, but a little more distant from the germ-bearing side than the line of the transverse axis, and expanding at the opposite end, which is lost in the layers of albumen near the poles of the egg. Thus, by their presence and place of attachment, these cords, called the *chalazæ*, restrain and regulate the rising of the yolk; so that whichever way an egg be turned, the larger proportion of the light yolk always rises above the attachment of the restraining cords, with the cicatricula upon its summit. The period of incubation is generally directly as the size of the bird, but the degree of developement which the chick attains prior to exclusion varies. As a general rule, it is inferior in birds of flight, as the Accipitrine and Passerine orders, than in the terrestrial, wading, and swimming birds; and the warmth and complexity of the nest bears relation to this difference of developement. If the thrush had been forewarned that her young would be excluded from the egg naked and helpless, she could not have prepared beforehand a warmer and more comfortable abode than her instinct had led her to construct for their accommodation; and if with such a nest we contrast the rude recess of straw in which the hen deposits and incubates her eggs, it might be imagined that she knew beforehand that her chickens would come into the world well clothed, and strong enough at once to run about and pick up their own food. In this case, therefore, the nest relates only to incubation; in the other to incubation and subsequent rearing of the young: and according to the degree of developement obtained during incubation, and the associated condition of the nest and habits of the parent, birds have been divided into two great groups, the *Aves altrices* and *Aves præcoces*. [AVIS.]

Incubation, Artificial. Artificial incubation has been practised from a remote period by the Egyptians and Chinese; the former, indeed, have carried this process to such a high degree of perfection, as in many instances to have entirely superseded the use of the hen in hatching. It is effected either by means of an oven, stove, or steam, the principles of which will be found detailed in Ure's *Dictionary of Arts, &c.* This process has received considerable attention from the French philosophers; but perhaps the best exemplification of its results witnessed in Europe is given by the *Eccalcobion*, or egg-hatching machine, exhibited in London. This term, invented to express the process of artificial incubation, is coined from the Gr. ἐκκαλέω, *I call out*, and βίος, *life*. [PISCICULTURE.]

Incubus (Lat. from incubo, *I lie upon*, because the sufferer feels as if something pressed upon his chest). The nightmare. The name incubus is derived from imaginary fiends or spectres. Many noble families were supposed to have their origin from the connection of incubi with females, as in the well-known instance of Robert of Normandy, called *le Diable*. For the theories on the intercourse of incubi and succubi with human beings, see Lecky, *Hist. of Rationalism*, ch. i. [EPHIALTES.]

Incumbent (Lat. incumbens, *leaning upon*). A term applied to the holder of an office; in popular language chiefly of an ecclesiastical benefice.

INCUMBENT. In Botany, applied to an embryo when its radicle is folded down upon the back of the cotyledons.

Incumbered Estates' Act, Irish. In consequence of a variety of causes, among which the too general improvidence of Irish landholders, and their reluctance to part with the appearance of territorial rights after the substance had passed to their creditors, were the chief, most of the landed property in Ireland had fallen into an extremely inconvenient and anomalous legal position. In many instances the judgments, mortgages, and other charges on estates greatly exceeded their value; the owner was, in fact, only a collector for others; and the number and variety of these incumbrances was so great that a sale frequently became impossible: the Court of Chancery being unable to afford the necessary relief by reason of its forms, which require the assent and co-operation of all parties, however remotely interested. In this state of things the Irish Incumbered Estates' Act was passed in 1849, after the famine of 1847 had drawn general and serious attention to the economical condition of the island. This Act provided that an incumbered estate might be summarily sold on judicial decree (pronounced by a court of three commissioners created for the purpose), on the application of the owner or of any incumbrancer, providing for the application of the purchase money among the parties entitled, and relieving the purchaser from any trouble or risk, by giving him a parliamentary title free from incumbrances. The practical effects of this measure were abundantly and rapidly felt. In September, 1858, it was estimated that more than 8,000 conveyances had been executed under the authority of the court, and that 23,000,000*l.* had been received on account of purchase moneys of estates sold under it, of which 3,000,000*l.* came from English and foreign purchasers, the remainder from Irish. These statistics appeared so convincingly to establish the value of the institution, that the system was rendered permanent by the Irish Landed Estates' Act of 1858, and made applicable to all estates, whether incumbered or not.

In 1854 a similar measure was enacted for the West Indies (West Indies Incumbered Estates' Act, 17 & 18 Vict. c. 117, amended by subsequent Acts), which can, however, only be put in force with the consent of each colony concerned. It is now in force in five islands, of which Jamaica is the principal, and extensive sales have been effected under it.

Incumbrance (Fr. encombrer, *to incumber*: Mod. Lat. comber, *a weir*—Ducange: Mr. Wedgwood, who denies—s. v. 'Comber'—that this word is derived from the Latin cumulus, *a heap*, connects it with the German kummer, Dutch komber, *trouble*). In Law, the general name for liabilities whereby property, and in especial property of freehold in lands and hereditaments, may be burdened; such as mortgages, dower, annuities, and the like. The rules of law and equity with respect to the adjustment of the rights and duties of different persons having interest in the inheritance, in respect of the discharge of incumbrances, are very minute and complicated. (Story's *Equity Jurisprudence*, § 486.)

Incunabula (Lat. *a cradle*). In Bibliography, a term applied to books printed during the early period of the art; in general confined to those which appeared before the year 1500.

Incurved (Lat. incurvus, *curved inwards*). In Zoology, when a part is curved inwards.

Indeclinable (Lat. indeclinabilis). In Grammar, a word admitting of no declension or inflexion. Adverbs, prepositions, particles, conjunctions, are all indeclinable. In classical languages, indeclinable nouns are the few nouns (chiefly borrowed by the Greeks and Latins from foreign languages) of which the termination is not altered in the several cases.

Indefinite (Lat. indefinitus, from finis, *an end*). In Botany, when stamens are above twenty in number; the word is applied to all other parts when their number is greater than can be readily counted. This term always refers in botany to number, and never to form.

Indefinite Integral. The general form of the sum of an infinite series of infinitesimal elements whose initial and final terms are undetermined. It may also be considered as any one of the functions which has a given function for its differential coefficient. The corresponding equivalent symbols for an indefinite integral are

$$\int F(x)\,dx \text{ and } \left(\frac{d}{dx}\right)^{-1} F(x).$$

[INTEGRAL CALCULUS.]

Indefinite Proposition. In Logic, one which has for its subject a common term, without any sign to indicate whether it is distributed or undistributed. [PROPOSITION.]

Indehiscent (Lat. in, and dehisco, *I gape*). In Botany, when the pericarpium of a fruit continues perfectly closed, without opening in any degree when ripe.

Indemnity (Lat. in, neg., and damnum, *loss*). In Politics and Jurisprudence, a word of various significations, but applied usually to laws passed to relieve individuals from penalties to which they are liable in consequence of acting in an illegal manner. The Act of Indemnity, annually passed by the

British parliament for many years prior to the repeal of the Test and Corporation Acts in 1828, was a measure for the relief of persons who had assumed any office without qualifying themselves for it by taking the oaths prescribed by those enactments. In Feudal Jurisprudence, the right of the lord to a certain duty payable by religious establishments to compensate him for the loss of those fines on alienation which would probably have accrued from time to time if their property had remained in lay hands, was termed *indemnity*. In the language of modern politics, compensations paid by a state to other states, corporations, or individuals, for losses sustained through its acts, bear the same name. Acts of indemnity are also sometimes passed to relieve ministers from the responsibility of measures exceeding their strict constitutional powers, taken by them when parliament was sitting, to meet some unforeseen public emergency, or in ignorance, it may be, that they had exceeded the powers vested in them by the constitution. Laws of *indemnity*, in the language of foreign jurisprudences, include laws for compensation. Thus in 1825 a law of indemnity was passed in France to compensate the losses sustained by the emigrants or their families, and those of persons who had been condemned to death for political offences in the course of the Revolution. The sum allotted to this purpose was an annual amount of 30,000,000 francs (about 1,200,000*l.*). A special commission was appointed to carry it into execution; but it appears that its labours were broken off before their completion by the political changes of 1830.

Indenture (from Lat. dens, dentis, *tooth*). In Law, a writing or deed comprising some contract between two or more parties. The name is derived from the ancient practice, according to which the original and counterpart original (to be retained by each party respectively) were written on the same skin of parchment, and then the two parts were separated by a notched or indented cut, so that when applied to each other they would appear to match. [DEED.]

Independence, Declaration of. In the History of the United States of America, the *Declaration of Rights* was adopted by the first general congress of the then revolted colonies which met at Philadelphia in September 1775. In this declaration that assembly claimed the right of internal legislation and taxation for the provincial legislatures, and declared various acts of the mother country to be infringements and violations of the rights of the colonists. The second congress, which met in May 1776, adopted on July 4 of that year a *declaration of independence*; by which, after again recapitulating the grievances complained of in the former declaration, it declared the colonies to be free and independent states, absolved from all allegiance to Great Britain. The first draught of this famous declaration was prepared by a committee of five; consisting of Jefferson and Adams (both afterwards presidents), Franklin, Sherman, and Livingstone. Jefferson and Adams were afterwards deputed as a sub-committee to prepare the declaration itself; but, in the shape in which it finally appeared, it was in fact the work of the former.

Independents. A Protestant sect; so called because they maintain that every single congregation forms a church or independent religious society in itself, unconnected with, and not amenable to, any other. They consequently condemn everything like a national establishment of religion, whether episcopal or presbyterian. They have always maintained, speaking generally, Calvinistic doctrines: their only peculiarity consisting in their maintenance of independent ecclesiastical government.

On the reformation of religion in England, the great body of Protestants adopted the episcopal form of church polity, which was established as the national religion. But there were not a few who conscientiously thought that this polity too nearly resembled that which had been supplanted. These nonconformists, or dissentients from the established faith, are known in history under the derisive name of *Puritans*, as the followers of Novatian had been denominated in the third century. [CATHARI.] But while they forsook the national church, and condemned many of her tenets, they did not agree among themselves. They were, in truth, unanimous in nothing but in resisting the constitution of the predominant hierarchy. Some of them were in favour of a presbytery, such as Calvin had established in Geneva, and as Knox had introduced into Scotland. Others were against every form of state religion, but regarded each congregation of Christians as being *jure divino* a complete and independent church. Of this latter opinion, which constitutes the pure principle of English Independency, the author and great advocate was Robert Brown, who was originally a clergyman of the episcopal church, from which he seceded, and avowed his new doctrines about the year 1580. (Neal's *History of the Puritans*, vol. i. ch. vi. London 1822.) Brown is represented by Neal as a vehement and popular declaimer, and insinuating in his manners. He not only advocated the leading principles of Independency as we have stated them above, but taught that the priesthood was neither a distinct order, nor conferred an indelible character; that every person regarded by the majority of a congregation as qualified to teach might be set apart for that office by the election of his brethren, and by imposition of their hands; in like manner, by their authority, he might be reduced again to the rank of a private Christian; and further, that any member who thought proper to exhort or instruct the brethren enjoyed the inherent right of doing so, or of *prophesying* before the whole assembly. Hence after the stated pastor had finished his services, the ordinary members were allowed to communicate in public their sentiments on any religious sub-

ject. But while Brown enforced these views, and claimed liberty of conscience to himself, he was not willing to allow similar privileges to other sects, particularly the church of England.

Brown and his followers suffered severely for their principles. He was committed, as he afterwards boasted, to thirty-two prisons in succession, in some of which he could not see his hand at noonday. Nor were his adherents more mercifully treated: many of them were fined and imprisoned, and some put to death. (Neal i. 313.) Under these circumstances, a body of the party, with Brown at their head, fled to Holland, and founded churches at Middleburg, Amsterdam, and Leyden. But these establishments were neither solid nor lasting. When the Brownists were delivered from the hands of the bishops their oppressors, they quarrelled among themselves; and their leader, weary of his office, came back to England in 1589, and returned into the church which he had so long and so severely calumniated.

The Brownists that still remained in Holland, learning moderation from experience, were not unprepared to modify or reform the severe discipline of their founder. This judicious change was brought about by John Robinson of Norfolk, member of the congregation at Leyden. (Mosheim v. 359–60.) Hitherto the sect had been called Brownists: they now renounced that name, and have since been known under the title of Independents; and Robinson, who wrote an apology for them (*Apologia justa et necessaria pro Exulibus Anglis, qui Brownistæ vulgo appellantur*, Lugd. Batav. 1619, 8vo.), was considered as their founder. They laid aside that hostility to other sects which Brown had inculcated, and differed with them only on the subject of church government. They were also much more attentive than the Brownists had been to the establishment of a regular ministry in their communities; for, while the latter allowed all ranks and orders of men to teach in public, the Independents had, and still have, a certain number of ministers chosen respectively by the congregations where they are fixed. Nor is any person among them permitted to speak in public till he has received the sanction of the congregation.

Independency, thus put on a more rational footing in Holland, was introduced into England by Mr. Henry Jacobs, who, in 1616, established the first Independent or Congregational church in this country. For some time, however, the sect made but slow progress in England. Its members concealed their principles from public view, to avoid the penal laws in existence against nonconformists. But during the latter part of the reign of Charles I. the Independents assumed greater courage, and publicly avowed their principles. From this period their progress was rapid; a circumstance that may be imputed in no slight degree to the support of Oliver Cromwell, who espoused their cause and enrolled himself among the list of their members. They probably were, during Cromwell's time, the most powerful and important religious body in England; though for a few years previous to the death of Charles I. the Presbyterians may be said to have had the ascendency. Indeed, presbytery had been established by Act of Parliament as the national church; and it was chiefly owing to the growing influence of the Independents that this Act was rendered inoperative. (Murray's *Life of Samuel Rutherford*, chap. viii. Edinburgh 1628.) Notwithstanding the *Apology* written by Robinson, the Independents as a body had not agreed on any standard of faith and discipline; but, in the year 1658, their leading members held a meeting in London, under the sanction of the Protector, and passed 'The Savoy Confession, or a Declaration of the Faith and Order owned and practised by the Congregational Churches in England, agreed upon and consented unto by the Elders and Messengers in their Meeting at the Savoy, Oct. 12, 1658.' This Confession, and Robinson's *Apology*, on which it is mainly founded, contain a synopsis of their various tenets; and from these it appears, as Mosheim remarks, 'that they differed from the Presbyterians or Calvinists in no single point of any consequence, except that of ecclesiastical government.' (Adam's *Religious World Displayed*, ii. 312–13.)

Thus matters stood at the date which we have just specified. What might have been the issue of the struggle between the Independents and Presbyterians if Cromwell had lived, or if his son had retained power, cannot be said. But the restoration of Charles II., and with him of the episcopal church, put an end to the influence of both sects. The Act of Uniformity, passed in 1662, was designed to crush nonconformists, particularly the Independents and Presbyterians. The Act required from clergymen a direct recognition of the principle of episcopacy. The effect of this was the retirement of about 2,000 clergymen from their respective churches—Independents, Presbyterians, and Baptists; whom Dissenters still characterise in history as 'the illustrious two thousand,' 'the ejected members,' or 'the Bartholomew worthies.' The Independents, however, though proscribed, still subsisted; but in a state of persecution, dejection, and weakness. The Revolution of 1688, and the Act of Toleration, which was passed in the subsequent year, brought them peace and the free exercise of their religion. They were now a small body as compared with the Presbyterians; but the two sects, having much in common, and differing only as to church government, entered into an association with each other, under certain heads of agreement, which tended to the maintenance of their respective institutions. (Whiston's *Memoirs of his Life and Writings*, vol. ii.; Mosheim v. 361–63.)

Since the period of the Revolution, the Independents have greatly increased both in numbers and importance. The extraordinary revival of religious zeal which took place about

the middle of last century, under the influence of the two Wesleys and Whitfield, was of essential service to the sect. Many other persons, awakened to a deeper sense of religion, refusing to unite with any of the three bodies of Methodists, the Wesleyan, the Whitfieldian, or the countess of Huntingdon's, joined the Independents, and formed numerous churches in connection with that sect. The Independents have long ago withdrawn from their association with the Presbyterians, or indeed with any body of Dissenters, and act by themselves.

Of the extent and influence of the Independents in England, a pretty correct idea may be formed from the number of their colleges or academies, and of their chapels. The former are exclusively confined to the education of ministers belonging to their own denomination. Some of these institutions are wealthy endowments: others of them are supported by annual subscriptions. Their number is ten; the oldest, at Homerton, Middlesex, having been founded in 1730. The number of Independent chapels in England and Wales, according to the census of 1851, was 3,244. In Scotland the Independents have upwards of 100 chapels, and in Ireland about 30; but it is reckoned that they have no fewer than 1,000 congregations in the United States; and the best authorities concur in stating that their numbers are on the increase.

Indeterminate (Lat. indeterminatus, *undefined*). In Botany, when a stem is never terminated by a flower, nor has its growth stopped by any other organic cause: example, *Veronica arvensis.*

INDETERMINATE. In Mathematics, this term is employed in various ways, and sometimes loosely. An *indeterminate problem*, for instance, denotes one which has an *infinite* number of solutions, not arbitrary but correlated; the indetermination arising, in fact, not from a *total*, but from a certain *degree of insufficiency* in the data; if the data were such as to render the problem capable of receiving a *finite* number of solutions, that problem would no longer be considered as indeterminate. [DETERMINATE PROBLEM.] *Indeterminate coefficients*, again, simply denote *unknown* coefficients. *Undetermined* would here be a less objectionable term.

Indeterminate Analysis. In its widest sense might be defined as that branch of Mathematics which has for its object the investigation of problems which admit of an infinite number of solutions. Ordinarily, however, the term is restricted to that branch of Algebra whose object is the determination of all possible solutions, in positive (or negative) integers, of a system of equations involving more unknown terms than there are equations. The general form of an *indeterminate equation* of the first degree is $ax+by=c$, where a, b, and c are positive or negative integers. If a and b have a common measure which will not divide c, the equation can, obviously, have no integral solutions. If a and b are prime to one another, however, then an integral solution may be found by converting $\frac{a}{b}$ into a continued fraction, and finding the convergent $\frac{p}{q}$ immediately preceding $\frac{a}{b}$. We shall then have $aq-bp=\pm 1$ [CONTINUED FRACTION], or $a\ (\pm qc)+b(\mp pc)=c$; so that $x=qc$ and $y=-pc$, or else $x=-qc$ and $y=pc$, will be an integral solution of the given equation. One such solution (α, β) being found, an infinite number can be at once determined. They are all included, however, in the formula $x=\alpha+bt, y=\beta-at$, where t is any integer whatever. The solution of a system of indeterminate equations of the first degree is reduced to that of the case just described. In systems of equations of higher degrees, the difficulties are immensely increased. The theory of indeterminate equations is closely connected with that of *congruences*, and thus forms a branch of the general *theory of numbers*; the works on the latter subject, therefore, may be consulted for further details.

The oldest treatise on the subject of the indeterminate analysis is the *Arithmetic* of Diophantus of Alexandria, the best edition of which is that of Toulouse, 1670; with a *Commentary* by Bachet, and notes by the celebrated Fermat. On the revival of the mathematical sciences, the subject was extensively cultivated by Fermat, Descartes, Wallis, Lord Brounker, and others. One of the most luminous elementary treatises on the subject is contained in the second volume of Euler's *Algebra.*

Indeterminate Coefficients. A method of analysis invented by Descartes, and of very extensive application in the higher mathematics. The principle of the method of indeterminate coefficients consists in this, that if we have an equation of this form,

$$A+Bx+Cx^2+Dx^3+\&c.=0,$$

in which the coefficients A, B, C are constant quantities, and x a variable which may be supposed as small as ever we please, each of these coefficients, taken separately, is necessarily equal to zero; that is to say, we must always have $A=0$, $B=0$, $C=0$, &c., whatever may be the number of terms of the given equation.

In fact, since x may be supposed as small as we please, it is always possible to render the sum of all the terms of the given equation which have x for a factor as small as we please; that is, the sum of all the terms following the first may be rendered as small as we please. Hence the first term differs from zero only by a quantity which may be less than any assignable quantity; but the first term A being constant, its difference from zero cannot be any finite quantity assumed at pleasure, for this would suppose it to be variable. It follows, therefore, that A can be nothing else than zero; that is, we must have $A=0$, whence there remains

$$Bx+Cx^2+Dx^3+\&c.=0.$$

Divide this last equation by x, and there results

$$B+Cx+Dx^2+\&c.=0;$$

and, for the same reasons as before, it is manifest that we must have $B=0$. Proceeding in the same manner, we find successively $C=0$, $D=0$, &c.

The principle here explained is extremely fertile in its applications; its rigorous demonstration, however, involves certain difficulties, for the statement of which we may refer the reader to De Morgan's *Algebra*.

Index (Lat.). A term often applied to the forefinger.

INDEX. In Bibliography, an alphabetical table, containing the principal subjects of a work, or of words employed in it, with references to the part of the work in which they are to be found. Many independent works, containing catalogues of various kinds, have been also entitled *index*.

INDEX. In Mathematics, this term may generally be considered as synonymous with *exponent*. In some branches, however, as in the theory of numbers, a conventional distinction is made between the two terms which it may be well to notice.

The *index of a number* to a given *base*, and for a given prime *modulus*, of which that base is a primitive root, is the index of the power of the base which is congruous to the number. Thus if r denote a primitive root of the prime p, in other words a primitive root of the congruence $x^{p-1}\equiv 1 \pmod{p}$. Then by FERMAT'S THEOREM any number n, prime to p, is congruous to some power of r, say $r^{\alpha}\equiv n \pmod{p}$. This being the case, α is said to be the *index of* n *to the base* r *for the modulus* p. It is clear that in place of α we may regard, as the index of n, any number congruous to α for the modulus $p-1$; so that symbolically expressed we have

$$\alpha = \mathrm{Ind.}_r\, n, \pmod{p-1}.$$

On the other hand, the *exponent to which the number* n *appertains* is the number of incongruous powers of n for the modulus p; this exponent has but one value, whereas the index of n, being obviously dependent upon the choice of the primitive root r, may have many values.

In 1839 the academy of Berlin, at the suggestion of Jacobi, who undertook the editorship, published the *Canon Arithmeticus*, which consists of a series of tables containing the numbers corresponding to given indices, and indices corresponding to given numbers.

INDEX. In Printing, the hand ☞ used for pointing out a remarkable passage, or one requiring particular attention.

Index Correction. The index error or correction of astronomical instruments, such as the sextant, is the difference, measured on the limb, between the zero point and the spot where the zero point would be when the movable and fixed reflectors are parallel.

Index Exponent. [MATHEMATICS.]

Index Expurgatorius (Low Lat.). A catalogue of works, which the church of Rome prohibits the faithful from reading, or condemns as heretical. It is annually published at Rome under the superintendence of a special congregation of cardinals, called the 'Congregation of the Index.'

Index of Refraction. In Optics, the constant ratio which exists for the same media between the sines of the angles of incidence and refraction. Thus, with respect to a ray of light falling obliquely on the surface of water, the sine of the angle of incidence is found by experiment to be to the sine of the angle of refraction in the constant ratio of 1·336 to 1. Hence 1·336 is the index of refraction in water [REFRACTION.]

India Paper. [PAPER.]

Indian Archipelago. This name is given to the vast and important group of islands extending between China and Australia. A long string of elongated islands, commencing with Sumatra and extending in a crescent shape to New Guinea, forms the boundary to the southwest. Within this outer line, Borneo, the Celebes, and the Philippine Islands, with Formosa, enclose the China Sea. Many of these islands are the richest and among the largest of all the islands of the earth. They are, however, little known, and a large number are not adapted for civilised man. A chain of volcanoes extends along the whole line, the active cones being closer together and more frequently in eruption than in any other group.

Of these islands, New Guinea is especially gigantic, and has rarely been entered by travellers. It measures 1,200 miles in length by nearly 500 in breadth, and its mountains attain a height of 16,000 feet. Borneo is somewhat smaller, but is rich in mineral and vegetable wealth beyond all known islands. The climate is healthy in many parts, although the island is crossed by the equator. Sumatra and Java are hardly less remarkable. The other groups are important, and are not far from the direct line of navigation from India to the China ports and the Japanese islands.

Indian Architecture. [ARCHITECTURE, INDIAN.]

Indian Corn. The popular name of the Maize, *Zea Mays*, a stout-growing grass, much cultivated as a corn crop in America and Southern Europe.

Indian Fire. A pyrotechnic composition consisting of seven parts of sulphur, two of realgar, and twenty-four of nitre. It burns with a brilliant white light.

Indian Ink. A species of ink used in water-colour painting, and for the lines and shadows of drawings. It is principally manufactured in China, and there used for writing. From the experiments of Dr. Lewis it appears to be a compound of fine lampblack and animal glue. [INK.]

Indian Ocean. This portion of the great ocean is in some respects an appendage to the Pacific, but is well separated from it by the great and important chain of islands of the INDIAN ARCHIPELAGO and the west coast of

Australia. It is a vast triangular basin, shut in to the north by the land of Southern Asia, Eastern Africa, and the chain of islands just mentioned, and only opening freely to the east and west between Van Diemen's Land on the one side and the Cape of Good Hope on the other, and the lands and icy promontories projecting beyond the Antarctic circle. Within this space is an area of 23,000,000 square miles.

The Indian Ocean includes several inland seas, as the Red Sea, the Persian Gulf, the Arabian Sea, and the Bay of Bengal. It also contains the vast but little known island of Madagascar. The peninsula of India projects far into it from the north in a regular triangle, terminated by Ceylon, and continued several degrees south of the equator by a chain of islands chiefly coralline. The oceanic warmth equator within it is almost everywhere ten degrees north of the terrestrial equator.

The winds of the Indian Ocean are periodical, and many parts of it are subject to storms of very extraordinary violence. The periodic winds are called MONSOONS. The great storms are limited to a belt of ocean whose northern limit is from five to eight degrees, and their southern limit between thirty and forty degrees south of the equator. The most severe storms occur on the African side of the ocean.

There are several broken currents in the Indian Ocean, but none of great importance except the MOZAMBIQUE CURRENT, passing between Madagascar and the mainland of Africa. A special account is given of this current, to which the reader is referred.

The coast line of the Indian Ocean is very considerable compared with its area; but, except in the larger seas already referred to, the coast is not very deeply indented. A very large and important drainage is received into it—the Ganges and Irawaddi, the Indus and Euphrates, and the great African river Zambesi, all pouring their waters into it. The latter river, however, though of the first class, does not appear to convey much fresh water. The Australian rivers are also inconsiderable affluents.

Indian Red. A kind of red ochre with a tinge of purple, imported from the Persian Gulf in small lumps, and as a coarse hard gritty powder. It is principally composed of silicate of iron; but the same name is applied to another mineral, also of a red colour, which consists chiefly of peroxide of iron. The well-known pigment Indian Red is made from these substances.

Indian Rubber. The inspissated milky juice of *Siphonia elastica*, *Ficus elastica*, and other plants. A curious and important modification of this article was discovered by Mr. Thomas Hancock; it is generally known under the name of *vulcanised Indian rubber*. It is caoutchouc combined with a very small proportion of sulphur. The several modes of effecting this are fully described in the specification of his patent. Vulcanised Indian rubber does not, like the ordinary article, become hard and rigid by cold, and it bears a very high temperature without change of properties. It is much more perfectly elastic than the common rubber, so that when stretched it does not acquire a set, but returns when released to its former dimensions. This discovery has rendered caoutchouc applicable to an infinity of purposes, for which, in its ordinary state, it is either unfit or objectionable. Among the most remarkable properties of vulcanised caoutchouc, is the resistance which it affords to naphtha, oil of turpentine, ether, oils, and a variety of other substances which are comparatively without action upon it, whereas they either soften or dissolve common rubber. [CAOUTCHOUC.]

Indian Yellow. [EUXANTHINE.]

Indianite. A mineral which occurs in granular masses, associated with Garnet, Felspar, and Hornblende. It is hard enough to scratch glass, and of a white or grey colour.

Indicative Mood (Lat. indicativus, from indico, *I point out*). That form of a verb which expresses a simple or unconditional judgment. [GRAMMAR.]

Indicator (Lat.). In Anatomy, a muscle of the lower part of the forearm which extends the forefinger.

INDICATOR. In Mechanics, the instrument employed for ascertaining the real power exercised by a steam engine, as well as the efficiency of the internal parts that are connected with the arrival and distribution of the steam. It acts by indicating the actual pressure in the cylinder during each stroke, as well as the time and manner in which the steam is admitted to and shut out by the valves which are placed upon the inlet pipe from the boiler.

INDICATOR. In Zoology, a genus of birds belonging to the cuckoo tribe (*Cuculidæ*), characterised by a straight finch-like bill, with compressed sides and a triangular base, the culmen and gonys being equally inclined towards the tip, and the gonys angulated; wings lengthened, pointed; tail moderate, rounded; feet short; middle toe much longer than the tarsus.

The species of *Indicator* are remarkable for their habit of indicating the nests of bees, and of guiding men to them by their motions and cries; whence both their scientific name and their common appellation of *honey-guides*.

Indicatrix. A name given by Dupin to a certain quadric curve which, traced upon the tangent plane of a surface, serves to determine all the accidents of curvature at the point of contact. Innumerable surfaces of the second order can be drawn to touch a given surface at a given point; so that the sections of both surfaces, by a plane through their common normal, shall have contacts of the second order. From this it follows that the curvature of both surfaces is identical at their point of contact. [CURVATURE OF SURFACES.] Now the section of this quadric by any plane parallel to the common tangent plane of the two surfaces is similar and similarly situated to the

indicatrix; whence it follows, from the well-known theory of the curvature of quadrics, that the squared radii vectores of the indicatrix are proportional to the radii of curvature of the parallel normal sections, that the axes of the directrix are parallel to the lines of curvature through the point of contact, and that the asymptotes of the indicatrix are parallel to the inflexional tangents, and its conjugate diameters to conjugate tangents. According as the indicatrix is an ellipse, a hyperbola, or a parabola, the point on the surface is said to be *elliptical*, *hyperbolic*, or *parabolic*.

It can be shown (Salmon's *An. Geom. of Three Dimensions*) that every tangent plane cuts the surface in a curve having a double point at the point of contact. Now the tangents at this double point will be imaginary, real, or coincident; that is to say, the point of contact will be a conjugate point, an ordinary double point, or a cusp, according as the same is elliptical, hyperbolic, or parabolic. Every point of a developable surface is parabolic, and on other surfaces the locus of parabolic points separates the elliptical from the hyperbolic points. This locus is the intersection of the surface with its Hessian, and is in general a curve of the $4n(n-2)^{\text{th}}$ order, if n be the order of the original surface. The tangent plane at a parabolic point is of the kind called *stationary*, because it coincides with one of the consecutive tangent planes, all of which, it may be remarked, pass through the line with which, at a parabolic point, the two inflexional tangents coincide. Thus parabolic points on a surface are analogous to points of inflexion on a plane curve. At the latter, the polar quadric degenerates to a couple of right lines; at the former, to a cone. The equation of the Hessian is precisely the expression of these conditions. Besides Dupin's *Développements de Géométrie*, and the work of Dr. Salmon, already cited, the reader must consult the more recent mathematical journals and *Phil. Trans.* for further information on this important branch of the theory of surfaces.

Indicatrix, Spherical. In Geometry, the spherical curve traced, on a unit-sphere, by the extremity of a radius drawn parallel to the tangent of a non-plane curve. The spherical indicatrix is often of use in studying the properties of non-plane curves. The plane of the great circle touching the indicatrix is obviously parallel to the osculating plane of the curve; its geodesic angle of contact is equal to the angle of torsion of the latter; its rectilinear tangents are parallel to the principal normals; its spherical evolute is the indicatrix of the cuspidal edge of the rectifying developable, &c. &c.

Indicavit (Lat. *he has shown*). In Law, a species of the writ of prohibition. It lies for a patron of a church, whose incumbent is sued in the spiritual court by another clergyman for tithes amounting to a fourth part of the profits of the advowson; and depends on stats. West. 2. c. 5, 13 Edw. I. stat. 4.

Indicolite. [INDIGOLITE.]

Indiction (Lat. indictio, *a declaring*). In Chronology, a cycle or period of fifteen years, the origin of which is involved in obscurity. Unlike other cycles, the indiction has no reference to any astronomical phenomena; but is supposed to relate to certain judicial acts, probably the publication of tariffs of the taxes, which took place at stated intervals under the Greek emperors. The Cæsarean indiction fell on the 8th of the calends of October (24th of September); the indiction of Constantinople (beginning A.D. 312) on the 1st of September; the pontifical indiction on the calends of January. It is a date commonly employed in very ancient charters. The commencement of this computation is generally referred to the 1st of January of the year 313 of the common era; hence, by counting backwards, it will be found that the first year of our era corresponded to the fourth of one of the cycles of indiction. The year of indiction corresponding to any other year of our era is found therefore by this rule: Add 3 to the date, divide the sum by 15, and the remainder is the year of the indiction. The remainder 0 indicates the 15th of the cycle. Thus the year 1800 was the third of the indiction. (See as to the historical commencement of the era of indictions, Gibbon's *Decline and Fall*, ii. 223, last ed.; *Mém. de l'Acad. des Inscr.* vol. xli.)

Indictment, Process by (Lat. indico, *I proclaim against*). In Law, all persons, without exception, are liable to be arrested on a warrant of a justice of peace, if charged on suspicion with a crime; and some officers, as the sheriff or constable, have the power of apprehending without a warrant on some occasions. When the party is arrested and brought before a justice of peace, he is examined, and the information of those who came with him is taken; and the depositions of the witnesses, if taken down in the presence of the prisoner, are evidence against him on the trial. If the offence be bailable, the justice must then take sufficient bail on the part of the prisoner. If otherwise, he commits him to prison; and the witnesses are bound over to attend and give evidence, the king being in all cases the nominal prosecutor. The grand jury being summoned by the sheriff (at every session of the peace, commission of oyer and terminer and gaol delivery), consisting of not fewer than twelve nor more than twenty-three of the principal men of the county, receives the *indictment* or *presentment* (as it is also termed) preferred against the prisoner, and either *finds* or *ignores* it; returning it into court, in the first case, indorsed a *true bill*; in the latter *not found*.

An indictment may be found in the absence of the prisoner; but cannot be tried unless he personally appears. The summons, when he is absent, in order to bring him into court, is by *capias*. When the prisoner appears on this process, or voluntarily, or is brought up in custody, he is *arraigned*; that is, called

before the bar to answer the indictment. If the prisoner refuse to answer (in which event he was subjected, in former days, to the famous *peine forte et dure*, by which it was intended to torture him into pleading, in order that the forfeiture of his goods might attach), a plea of not guilty is now recorded, and the trial proceeds; if he plead guilty, judgment is awarded. Otherwise he may plead—1. To the jurisdiction; i.e. that the court before which he is arraigned is not competent to try the offence. 2. Formerly in abatement for misnomer; but the advantage of this plea is now taken away by 7 Geo. IV. 3. He may demur to the sufficiency in law of parts of the indictment. 4. He may plead one of the four special pleas in bar (former acquittal, former conviction, former attainder, and pardon). 5. He may plead not guilty of the crime alleged. If the prisoner plead not guilty, the fact of his guilt is forthwith tried on examination of witnesses by the petty jury. The nobility, it must be observed, are tried by their peers for treason or felony, and misprision of these crimes; but in other cases by a jury. The jurors are taken by the panel or list returned by the sheriff; and *criminal offences* are tried by the same common jurymen who try the issue of facts in civil cases in which a *special* jury has not been demanded. [JURY.] The rules of evidence observed on the trial are mostly the same with those which prevail in civil actions. [EVIDENCE.] One testimony, however, peculiar to this branch of law, is that of an accomplice; but it is considered essential that his testimony should be confirmed by other evidence. The verdict of the jury must in all cases be unanimous. After trial and conviction follows judgment, unless arrested by motion for that purpose, which it still may be on some exceptions to the indictment in point of law. BENEFIT OF CLERGY [which see] was usually prayed after conviction; and was held, in cases where not abolished by statute, to discharge the claimant from the capital part of the punishment. But this ancient privilege, which had long been founded on a mere fiction of law, was abolished by 7 & 8 Geo. IV. c. 28. Forfeiture of real property, absolutely, is a consequence of judgment in cases of high treason. The forfeiture of goods and chattels relates to, that is takes effect upon, conviction; but fraudulent conveyances without consideration, in order to escape the forfeiture by the transfer of the property after or in contemplation of indictment, are void as against the king. The sentence of punishment pronounced or recorded on judgment is in some cases fixed and stated, so that the judges cannot modify the statutory penalty; in others (as in all offences at common law unregulated by statute) it is wholly or partly discretionary.

A criminal judgment may be reversed by writ of error for notorious mistakes and irregularities. A reprieve suspends the execution of a judgment: a pardon avoids the judgment altogether; and a pardon may be conditional on the prisoner's submitting to a substituted punishment, which is the ordinary mode of mitigating the severity of the law in capital felonies. [LAW, CRIMINAL.]

Indigestion. [DYSPEPSIA.]

Indigetes (Lat.). The Latin title for the indigenous heroes of the land, who after death were ranked among the gods; as Latinus, Æneas, Romulus, and others.

Indigo. A blue substance much used as a dye-stuff. It has been the subject of much chemical research, and its direct and indirect derivatives are very numerous. The best indigo is obtained from an Asiatic and American plant, *Indigofera tinctoria*. The plant is bruised and fermented in vats of water, during which it deposits indigo in the form of a blue powder, which is collected and dried, so as to form the cubic cakes in which it usually occurs in commerce. Indigo is insoluble in water; when heated it yields a purple vapour, which condenses in the form of deep blue or purple acicular crystals termed *indigotin* $= C_{16}H_5O_2N$, which may be regarded as pure *indigo-blue*. When indigo is exposed to the action of certain deoxidising agents, it becomes soluble in alkaline solutions, losing its blue colour and forming a green solution, from which it is precipitated by the acids *white*; but it instantly becomes blue by exposure to air. This *white indigo* has been termed *indigogen* or *reduced indigo* $=C_{32}H_{12}O_4N_2$, so that in respect to ultimate composition, indigogen is a hydride of indigotin, and the white soluble condition of indigo passes into the blue insoluble condition by the abstraction of two atoms of hydrogen. Indigogen is best obtained by mixing 3 parts of finely powdered and pure indigo with 4 of green vitriol, 5 of slaked quicklime, and 100 of water, repeatedly shaking the mixture. In about twenty-four hours the supernatant liquor, which is transparent, and of a green colour, is to be decanted off, and poured into dilute hydrochloric acid, when the deoxidised indigo is thrown down; but in order to prevent its absorbing oxygen and becoming blue, it must be most carefully excluded from the contact of air, which may be effected by siphoning it off into the acid, collecting it in vessels filled with hydrogen, and washing it with water deprived of air and holding in solution a little sulphate of ammonia.

When indigo is dissolved in concentrated sulphuric acid, it forms a deep blue liquid, known to the dyers by the name of *Saxon blue*. The great mart for indigo is Bengal, and the other provinces subject to the presidency of that name, from the twentieth to the thirtieth degree of north latitude; but it is also cultivated, though not nearly to the same extent, in the province of Tinnevelly, under the Madras government; in Java; in Luconia, the chief of the Philippine Islands; and in Guatemala and the Caraccas in Central America. The following remarks, from the *Commercial Dictionary*, will exhibit the history of this now indispensable commodity, and the difficulties

with which it had to contend before it obtained a permanent footing in the commerce of Europe.' 'It appears pretty certain that the culture of the indigo plant, and the preparation of the drug, have been practised in India from a very remote epoch. It has been questioned, indeed, whether the *indicum* mentioned by Pliny (*Hist. Nat.* lib. xxxv. c. 6) was indigo; but, as it would seem, without any good reason. Pliny states that it was brought from India; that when diluted it produced an admirable mixture of blue and purple colours (*in diluendo misturam purpuræ cæruleique mirabilem reddit*): and he gives tests by which the genuine drug might be discriminated with sufficient precision. It is true that Pliny is egregiously mistaken as to the mode in which the drug was produced; but there are many examples in modern as well as ancient times to prove that the possession of an article brought from a distance implies no accurate knowledge of its nature, or of the processes followed in its manufacture. Beckmann (*Hist. of Inventions*, vol. iv. art. 'Indigo') and Dr. Bancroft (*Permanent Colours*, vol. i. pp. 241–252) have each investigated this subject with great learning and sagacity; and agree in the conclusion that the *indicum* of Pliny was real indigo, and not, as has been supposed, a drug prepared from the *isatis* or woad. At all events, there can be no question that indigo was imported into modern Europe, by way of Alexandria, before the discovery of the route to India by the Cape of Good Hope. When first introduced, it was customary to mix a little of it with woad to heighten and improve the colour of the latter; but, by degrees, the quantity of indigo was increased; and woad was, at last, entirely superseded. It is worth while, however, to remark, that indigo did not make its way into general use without encountering much opposition. The *growers of woad* prevailed on several governments to prohibit the use of indigo! In Germany, an imperial edict was published in 1654, prohibiting the use of indigo, or *devil's dye*, and directing great care to be taken to prevent its clandestine importation; "because," says the edict, "the trade in woad is lessened, dyed articles injured, and money carried out of the country!" The magistrates of Nuremberg went further, and compelled the dyers of that city to take an oath once a year not to use indigo; which practice was continued down to a late period. In 1598, upon an urgent representation of the states of Languedoc, at the solicitation of the woad growers, the use of indigo was prohibited in that province; and it was not till 1737 that the dyers of France were left at liberty to dye with such articles, and in such a way, as they pleased.'

Indigo blue exists in fresh urine as indican, which passes into insoluble indigo blue during the fermentation of the liquid. It has also been found in cow's milk. Indigo, when submitted to dry distillation, yields amongst other products a considerable quantity of aniline, the remarkable organic base from which the celebrated coal-tar colours are produced.

Indigogene. *Indigo white.* [INDIGO.]

Indigolite. A name given to blue *Tourmalines* on account of their colour.

Indigotic Acid. An acid obtained by boiling indigo in nitric acid diluted with an equal weight of water. It forms white crystals, very soluble in hot water, but very sparingly soluble in cold water.

Indigotin. The sublimate obtained by heating indigo. [INDIGO.]

Indin. A pulverulent rose-coloured body produced by the action of potash on sulphisathyd, a derivative of indigo.

Individual (Lat. individuus, *that cannot be divided*). In Biology, that organic whole which is generated, may generate, and dies. Some would restrict the definition to a special mode of generation, as, e.g., from an egg or seed directly fertilised by sperm or pollen. According to this opinion, all the well-grown 'mottled laurels' (*Aucuba japonica*) in England, all the Aphides that swarm upon a rose-bush, and, possibly, every drone of a hive, are severally disentitled to be called *individuals*, and are held to be mere parts and outgrowths of one and the same indefinitely extended *individual*; which individual, recognised as such agreeably with the restricted definition, prior to such *outgrowths*, may have long been dead and rotten; as, e.g., in the case of the Aphis from the directly fertilised *germ-cell* dying after giving birth to the progeny from derivatively fertilised germ-cells; and in the case of the mother-bee from the primarily fecundated egg, dying after oviposition of the secondarily fecund eggs from which male bees only are developed. Nothing is needed but a recital of the consequences, to stultify the definition of an organic *individual* as 'the total result of the developement of a single egg or seed,' or 'the entire product intervening between one act of sexual generation or direct fertilisation and another.'

INDIVIDUAL. In the Fine Arts, that which is proper or peculiar to a single object of a species.

Indivisibles (Lat. indivisibilis). Infinitely small quantities which admit of no further division.

The *method of indivisibles* is the name given to a peculiar species of calculus, invented by Cavalieri, a disciple of Galileo, and much used by mathematicians before the invention of the method of fluxions or of the differential and integral calculus, for which it prepared the way, and of which to a certain extent it supplied the place. Its logic, perhaps, is inferior to that of the infinitesimal calculus, but its results are equally accurate. Lines are considered as composed of points, infinite in number, surfaces as composed of an infinity of lines, and solids again as aggregates of surfaces. Cavalieri was born at Milan in 1598; his *Geometria Indivisibilis Continuorum &c.* was published at Bologna in 1635. His method of indivisibles

was attacked by Guldinus, to whom Cavalieri replied in a subsequent work entitled *Exercitationis Geometricæ Lex*, and published in 1647. Roberval also laid claim to the invention of the method of indivisibles, but his publications on the subject were posterior to those of Cavalieri. (*Mém. de l'Acad. Roy. des Sciences*, t. 6; Paris 1730.)

Indo-European (compound of *Indian* and *European*). A term (stigmatised by Dr. R. G. Latham as 'erroneous and inconvenient') used to include the German, Sarmatian, Græco-Latin, Keltic, and Skipitar 'races;' when restricted to the three first, the term *Indo-Germanic* is used. Such terms 'keep their place, and must be used, however unfit for use.' (Latham.) Upon the hypothesis that all the above nations are of common origin, the term ARYAN has been proposed [which see].

Indorsement. [EXCHANGE.]

Inducement (Lat. induco, *I lead into*). In Law, a term used especially in various cases to signify a statement of facts alleged by way of previous explanation or introduction to other material facts. Averments which are mere inducement need not be proved so precisely as others.

Induction (Lat. inductio, from duco, *I lead*; termed in Greek philosophy, ἐπαγωγή). The counter-process in scientific method to *deduction*, implies the raising individuals into generals, and those into still higher generalities; deduction being the *bringing down* of universals to lower genera or to individuals. Every deduction, therefore, to be valid, must rest on a prior induction, which, in order that we may obtain logical certainty, must be a *complete* induction: that is to say, must include *all* the individuals which constitute the genus. This, it is evident, is impossible, so long as we assume the only power necessary to induction to be the observation of particulars; for these are infinite in number; we can never be sure that we have observed them all. We are therefore compelled, if we are to admit the possibility of science properly so called, to allow the necessity of some spontaneous action of the understanding in every inductive process; of a faculty, in short, which takes occasion from experience to arrive at the knowledge of truths not contained in that experience. Philosophers differ widely in the language under which they convey their belief of this truth. Had the thing itself, however, been more distinctly borne in mind, we should have been saved much useless obscurity; in particular, we should have escaped that altogether futile distinction made by logicians between 'perfect and imperfect induction.' All the certainty that can be obtained in physics is a hypothetical certainty, founded on our belief that the course of nature is uniform; but the form of our reasoning, which is all that the logician contemplates, remains the same whether the certainty be real or assumed. Speaking generally, we may ascribe the developement of all modern science to the employment of the inductive method, which refuses to admit any fact or accept any statement or mere authority, and declines all evidence except that of actual experiment or observation, all ancient systems of philosophy having followed the deductive method, i. e. reasoning from a preconceived theory with which phenomena must be made to fit. (Playfair, *Introd. Essay to the Ency. Brit.*; Hallam, *On the Literature of Europe*, vol. iii.; Mill, *System of Logic*.) [LOGIC.]

INDUCTION. In Ecclesiastical Law, the admission of a clerk presented to a benefice to the temporalities thereof. The archdeacon has of common right the power to induct: other officers, in some cases, by prescription; or by the bishop's appointment. The form of induction is by introducing the incumbent within the door of the church. [INSTITUTION.]

Induction, Electrical. A body charged with electricity disturbs the electrical condition of all surrounding bodies; thus, if a sphere A, charged with positive electricity, be brought

near a metallic cylinder B, the latter becomes *electropolar*, its negative electricity being attracted to the end of the cylinder nearest A, whilst its positive electricity is repelled to the opposite extremity. This action of an electrified body upon surrounding matter, unconnected with it by a conductor, is termed *induction*. [ELECTRICITY.]

Induction, Mathematical. A peculiar method of demonstration frequently employed in establishing the general truth of a proposition which is known to be true in one or more particular cases. To illustrate the process, let it be required to show that $x^n - y^n$ is exactly divisible by $x - y$ for all integral values of n. From the identity

$$x^{n+1} - y^{n+1} = (x^n - y^n)\,x + (x - y)\,y^n$$

we at once conclude that if the proposition were true for any *one* integral value of n, it would be true for the next higher value $n+1$; but it is manifestly true for $n=1$; hence, by *successive induction*, it holds for $n=2, 3, 4,$ &c., . . . in short, for all integral values of the exponent.

Indulgence (Lat. indulgentia). A power claimed by the Roman Catholic church of granting remission for a certain term, either on earth or in purgatory, of the penalty due to sin. The practice was first instituted in the eleventh century by Popes Gregory VII., Victor, and Urban II., as a recompense to those who embarked in the perilous enterprise of the Crusades; but its benefits in process of time extended to all who, either by donations or other services, contributed to the well-being of the church. The profligate sale of indulgences first excited Luther to commence his warfare against the see of Rome; and although the traffic in indulgences has been reprobated by many councils, and some minor corruptions

have been partially reformed, still the council of Trent decreed the usefulness and validity of such instruments, and left the whole control of their nature and manner of issuing them entirely in the discretion of the pope for the time being.

Indult (Lat. indultus, part. of indulgeo, *I indulge*). In Ecclesiastical Law, a peculiar form of dispensation from requirements of the ordinary law, granted by the pope.

Indumentum (Lat. from induo, *I put on*). In Zoology, the term is restricted in its signification to the plumage of birds. This consists of the peculiar epidermic organs called *feathers* and *down*, with sometimes a scanty admixture of hair. [FEATHERS.] The plumage is generally more than once changed before it attains that state which is characteristic of the fully mature bird. The period during which these mutations are proceeding varies from one to five years, and many birds rear a progeny before they acquire the plumage of maturity. When the indumentum of the male bird differs in colour from that of the female, the young birds of both sexes resemble the latter in their first plumage; but when both the adult male and female are of the same colour, the young have then a plumage peculiar to themselves. In some species the adult birds have a plumage during the breeding season decidedly different in colour from that which they bear in winter: in these cases the young birds differ in colour from both parents, and have a plumage which is intermediate in its general tone to that of the two periodical states of the parent birds, and bearing indications of the colours to be afterwards attained at either period.

The changes in the colour of the plumage of birds are effected either by a total moult of the old and the acquisition of new feathers; or by a partial moult, and the admixture of new feathers with a certain proportion of the previous plumage; or on the bird's obtaining a certain number of new feathers without shedding any of the old ones; or, lastly, by the fully formed feather itself becoming altered in colour. The last two changes take place in the adult birds at the approach of the breeding season. The change of colour of a fully developed feather is produced either mechanically by the wearing away of the lighter coloured tips, which exposes the brighter tints of the plumage beneath, or by some internal chemical or vital influence upon the colouring matter of the feather itself: the latter change begins at that part of the web nearest the body of the bird, and gradually extends outwards till it pervades the whole feather.

Indus. In Astronomy, the Indian, one of the constellations.

Indusial Limestone. A fresh-water limestone found in Auvergne, abounding in the indusiæ or cases of the larvæ of *Phryganea*, great heaps of which have been incrusted by hard travertin and formed into rock.

Indusium (Lat. from induo). In Botany, the cup that surrounds the stigma of Goodeniaceous and some other plants. Also the name of the membrane that covers the thecæ or spore-cases in Dorsiferous ferns.

Induviæ (Lat.). In Botany, the withered remains of leaves which, not being articulated with the stem, cannot fall off; the part covered by them is said to be *induviate.*

Inequality. In Astronomy, this term is applied to any deviation in the motion of a planet or satellite from its uniform mean motion. The *great inequality* of Saturn and Jupiter is a variation in the orbital motions of these planets caused by their mutual attractions.

The moon's parallactic inequality is one of great interest, as from it the sun's distance can be determined.

Inertes (Lat. iners, *slothful*). The name of an order of birds in the ornithological system of Temminck, including the *dodo* and *apteryx.*

Inertia (Lat. from iners). This term is used to denote the principle or law of the material world, that all bodies are absolutely passive or indifferent to a state of rest or motion, and would continue for ever at rest, or persevere in the same uniform and rectilinear motion, unless disturbed by the action of some extrinsic force. The ancients attributed to matter a certain inaptitude or reluctance to motion; but that a body in motion required the operation of an extrinsic cause to bring it to rest was first stated by Galileo. Kepler, conceiving the disposition of a body to maintain its motion as indicating an exertion of power, prefixed the word *vis*; and the compound expression, *vis inertiæ*, though less accurate, has been generally retained. Inertia is one of the inherent properties of matter, and unceasingly recalled to our observation in every incident of life.

Inertia, Moment of. In Mechanics, the sum of the products of the masses of the particles of a body into the squares of their respective distances from a given axis is called the *moment of inertia* of the body with respect to that axis. Thus if dm denote the element of mass, and r the distance of this element from the axis, the moment of inertia will be $\int r^2dm$, if the integration be extended to all particles of the body. If we denote by $M=\int dm$ the whole mass of the body, and determine k so that $M k^2=\int r^2dm$, then k is termed the *radius of gyration* or *arm of inertia*; it is the distance from the axis at which a material particle, whose mass is equal to that of the body, must be placed in order to have the same moment of inertia. The *principal moments of inertia* with reference to any point of a body are its moments of inertia with respect to the principal axes passing through that point. Calling them A, B, and C respectively, and denoting by H the moment of inertia with respect to any other axis through the same

point, inclined to the principal axes at the angles α, β, γ, respectively, then

$$H = A\cos^2\alpha + B\cos^2\beta + C\cos^2\gamma.$$

The rotation axes for which H is constant are clearly the generators of a quadric cone called the *equimomental cone*. If H_0 represent the moment of inertia about an axis passing through the centre of gravity and parallel to that which corresponds to H, and h denote the distance between the two axes, then

$$H = H_0 + Mh^2,$$

so that of all parallel axes the moment of inertia is the least for that which passes through the centre of gravity, and it is the same for all parallel axes which are equidistant from that centre. Knowing the principal moments of inertia, A_0, B_0, C_0, with respect to the centre of gravity, therefore, the moment of inertia with respect to any axis whatever is given by the formula

$$H = A_0\cos^2\alpha + B_0\cos^2\beta + C_0\cos^2\gamma + Mh^2.$$

The ellipsoid whose centre is at any point O, whose semi-axes have the same directions as the principal axes, and are inversely proportional to the principal radii of gyration at O, is called the *momental ellipsoid* at that point, or the *central momental ellipsoid* if the point O coincides with the centre of gravity. The of each radius vector of a momental is inversely proportional to the mo- of inertia relative to that radius vector as axis of rotation. The polar reciprocal, with respect to a certain concentric sphere, of a momental ellipsoid is termed an *ellipsoid of gyration*; it is coaxal with the momental ellipsoid, and has the principal radii of gyration for semi-axes. The radii vectores of the central pedal of this ellipsoid of gyration are precisely equal to the radii of gyration relative to axes of rotation which coincide with the said vectores.

The above equimomental cone is not to be confounded with what Prof. W. Thomson has called the *equimomental surface* (*Cambridge and Dublin Mathematical Journal*, vol. i.). This is the locus of all points at which *one* of the principal moments of inertia has a given constant value, $H = Mk^2$. It is a surface of the 6th order whose equation is

$$\frac{}{r^2+a^2-k^2} \qquad \frac{y^2}{r^2+b^2-k^2}$$

$$+ \frac{}{r^2+c^2-k^2} = 1,$$

where a, b, c are the principal radii of gyration, and

$$r^2 = x^2 + y^2 + z^2.$$

Inescutcheon (Lat. scutum, *a shield*). In Heraldry, a species of ordinary, being an escutcheon placed upon the fess point [FESS]; and containing, it is said, the third part when charged, the fifth when otherwise. All escutcheons borne within escutcheons are by some heralds called by this name.

Infallibility (Lat. in, neg., and fallo, *I deceive*). This attribute is claimed by the church of Rome in matters of faith, but denied by Protestants. The church of England declares in her 19th Article: 'As the church of Jerusalem, Alexandria, and Antioch have erred, so also the church of Rome hath erred, not only in their living and manner of ceremonies, but also in matters of faith.' Among the Roman Catholics themselves there is a difference of opinion as to where this presumed infallibility rests, whether in the pope himself or in general councils.

Infant (Lat. infans, literally *speechless*, like the Greek νήπιος). In Law, a person under twenty-one years of age. He is not considered in law as having sufficient ability to contract, and is protected from his own improvidence and the artifices of designing persons by his not being liable for any engagements into which he may have entered, except for necessaries suited to his condition in life. Of his contracts, however, many are not absolutely void, but only voidable; and though they cannot be enforced against him, yet he may, if he do not choose to avoid them, enforce them against another, and may always confirm them on the termination of his minority. He is in general responsible in damages for torts committed by him, as for slander, or assault. His responsibility for crimes varies according to his age and discretion: under seven years of age he cannot be guilty of felony; between seven and fourteen a presumption arises that he is doli incapax; but this presumption may be repelled by proof that he could plainly distinguish between good and evil, and he may then suffer death as a felon; and after fourteen he is in general as amenable to punishment as a person of full age.

His disabilities, many of which are in the nature of privileges, and established for his protection, are numerous: he cannot fill any office connected with the administration of justice, or sit in parliament; he cannot be an executor, nor appear in court by attorney. The consent of parents or guardians, or of the Court of Chancery, is requisite to his marriage.

Infant Baptism. The practice of baptising infants, adopted from early Christian usage, with the presumed warrant of Scripture (St. Mark x. 13), by the Roman Catholic, the Greek, Anglican, and by the greater number of Protestant churches. It is rejected by the Baptists, more properly called Anti-paedobaptists. [ANABAPTISTS.]

Infante, Infanta. The titles borne by the younger sons and the daughters of a king of Spain, the eldest son being styled Prince of Asturias. It is found in a document of the year 999, applied to the sons of King Veremont II. It appears, however, to have been anciently given to all hidalgos. (*Quart. Rev.* vol. lxii. p. 104, where the reader is referred to the 'Ley de Partidas,' 1, 2.) The word *childe* was similarly used in England in the middle ages.

Infanticide or **Child-murder.** By the law of England, infanticide is placed upon the same footing with other homicide. By 24 & 25 Vict. c. 100, a person indicted for the murder of a child may, if acquitted of the murder, be convicted of the misdemeanour of secreting the body of the child to conceal its birth. To administer poison, or use other means to procure the miscarriage of a woman great with child, is also a felony by the same statute (c. 59). The exposure of new-born infants, particularly females, is a common practice among many savage nations at the present day, and especially prevalent among the Chinese. According to Lord Macartney, the number of infanticides committed in Pekin alone exceeds 20,000 a year. In some countries polyandry is the result of this practice.

Infantry (Lat. infans, used in the middle ages in the sense of *boy* or *servant*: as during the middle ages servants went on foot, while the knights rode on horseback, *infanteria* became the name of foot soldiers in general). Among the ancient Greeks and Romans, the infantry constituted the chief strength of an army; and, with the exception of that period in European history during which the institutions of chivalry prevailed, when the tournament with its gay appendages engaged the attention of all the powerful nobles, and thus imparted to the *cavalry* a factitious importance, it has generally been regarded as the principal military arm. Since the institution of standing armies this has been peculiarly the case. From the period of the Conquest down to the reign of Henry VIII. the infantry of this country consisted of the inferior vassals of the feudal tenants, and from the cause above referred to was neglected both in discipline and accoutrements; but the connection of that monarch with Charles V. of Germany and Francis I. of France, whose rivalry in arms had introduced great improvements into this arm, was the means of directing attention to the defects of the English infantry, and paved the way for the introduction of that system of discipline which after the lapse of three centuries has now brought it to perfection. The infantry of the British army comprises, exclusively of the native Indian troops, 3 regiments of guards, 109 regiments of the line, a rifle brigade, and 11 colonial regiments and corps. Of the regiments of the line 83 have each 1 battalion, 25 have 2 battalions, and the 60th and rifle brigade 4 battalions each, in all 141 battalions, of which 8 are rifles and 12 Highland. There are 11 battalions of light infantry, and 9 of fusiliers. The last 9 regiments are formed from the troops of the late East India Company. [ARMY.]

Infection. [CONTAGION.]

Infeftment. [INFEUDATION.]

Inferiae (Lat.). Sacrifices offered by the Greeks and Romans to the Dii Manes, or the souls of deceased heroes, or any person whose memory was held in veneration. These sacrifices consisted of almost every kind of offering, and were instituted on the ninth and thirtieth days after interment.

Inferior (Lat.). In Botany, a term given to a calyx distinct from the ovary, as in *Silene*; or to an ovary which adheres to the calyx, as in the myrtle. It is, in Dr. Lindley's judgment, a bad expression, though commonly employed; the French school have substituted for it the words *nonadherent* and *adherent*.

Inferior Oolite. A fine and useful series of strata containing beds of freestone of oolitic structure, much worked at Dundry and other places near Bristol, and also near Cheltenham, and forming part of the lower division of the Oolitic series of England, is recognised by English geologists under this name. The beds pass downwards into the Lias, and the intermediate deposit is often sandy. The Inferior Oolite is separated from the Great Oolite, which contains much better freestone, by the *Fuller's earth* and *Stonesfield slate*.

The Inferior Oolite is a local subdivision, not important out of England, though recognisable in Normandy. Several species of shells, chiefly bivalves, are regarded as locally characteristic of it. Although the Inferior Oolite is separated from the Lias by the Dundry beds already mentioned, the fossils seem to vary in little more than the inevitable difference between clays and limestones. [OOLITE, GREAT.]

Infero-branchiata (Lat. inferus, *lower*; Gr. βράγχια, *gills*). An order of Gastropods, characterised by the position of the gills, which are situated beneath the produced margin of the mantle; they consist of two long series of leaf-shaped vascular organs. This order comprehends, in the system of Cuvier, two genera, *Phyllidia* and *Diphyllidia*.

Infeudation. In Feudal Law, the placing in possession of a fee or freehold estate. [FIEF.] In English Law, the term was sometimes used to designate the granting of tithes to laymen.

Infinite and Infinitesimal (Lat. infinitus, *not bounded*). An infinite quantity denotes one which is greater than any assignable quantity; an infinitesimal quantity, one whose magnitude is less than that of any assignable quantity. The greater the number of parts into which a finite magnitude is divided, and the less each part becomes, the process of division being conceived to be continued indefinitely, we say that the magnitude consists of an infinite number of infinitesimal elements. Proper precautions being taken, this *convention* leads to no erroneous results, and greatly simplifies our enunciations. The precautions consist in carefully observing the *manner* in which a proposed quantity may become infinite or infinitesimal; for the *ratio* of two magnitudes, each of which is infinite or infinitesimal, in the above sense, may be either finite, infinite, or infinitesimal. Thus the sine and tangent of an angle both diminish as the angle diminishes, and approach a ratio of equality. The sine and versed sine also diminish, individually, as the angle diminishes, but

the ratio of the first to the second increases under the same circumstances, and finally ceeds any assignable ratio, in other words becomes infinite. We are thus led to the consideration of infinities and infinitesimals of *different orders*. The evanescent versed sine would be said to be an infinitesimal of the *second order* in comparison with the infinitely small sine. The symbols for infinitely great and small quantities are ∞ and 0; and from the above remarks it will be at once seen in what manner we must interpret such expressions as $\frac{a}{0} = \infty$ and $\frac{a}{\infty} = 0$, where a denotes a finite magnitude; as also in what sense $\frac{0}{0}$ and $\frac{\infty}{\infty}$, 0^{∞} &c. are indeterminate. With reference to these symbols, it must be borne in mind also, that whereas we have an *absolute zero*, when one of two equal magnitudes is subtracted from the other, we have no *absolute infinity*.

The *infinitesimal calculus* is simply the differential calculus propounded, in Leibnitz's manner, according to the theory of infinitesimals. The geometrical *method of infinitesimals* is another application of the same principles, and is of the greatest utility. Curves are therein considered as polygons possessing an infinite number of infinitesimal sides. The term *infinity* occurs frequently in modern geometrical phraseology, and when properly understood is not only convenient, but advantageous, through the uniformity of enunciation which is thereby secured.

Thus two parallel right lines are said to intersect in an infinitely distant point, in order that they may be included in the general law. The infinitely distant points of a plane are considered as situated in a right line, *the line at infinity* or intersection of any two parallel planes. Again, the infinitely distant points of space may be regarded as situated in the *plane at infinity*, and so on.

The metaphysical difficulties inseparable from the present subject are ably discussed in a paper by Prof. de Morgan (*Transactions of the Cambridge Philosophical Society*, vol. xi. part i.).

Infinitive Mood. In Grammar, that inflexion of the verb which expresses the conception merely, without affirming or denying it, of any subject. [GRAMMAR.]

Infirmary (Lat. infirmus, *weak*). An hospital for the reception of the sick poor, either supported by the public, or endowed by benevolent persons with funds to defray the necessary expense. Establishments bearing this name are not uncommon in all considerable towns of the British empire. [HOSPITAL.]

Inflammation (Lat. inflammatio, *an inflaming*). In Pathology, this term is applied to redness and heat of some part of the body, attended by pain and swelling: the vascular action of the part being increased. Inflammation terminates either in *resolution*, *suppuration*, *ulceration*, or *gangrene*, according to the constitution of the patient and the nature of the cause which gave rise to it.

Inflexed (Lat. inflexus, part. of inflecto, *I bend*). In Zoology, when a part is bent inwards.

Inflexion (Lat. inflexio, *a bending*). In Grammar, that process which modifies declinable words in languages where the pronominal and predicative roots may be so combined as to form one word. This cannot take place in radical or monosyllabic languages like the Chinese, or the agglutinate languages of the Turanian family. Hence, the Semitic and Aryan tongues are called *inflexional*. Thus in the Latin future *amabo*, or the Greek future τυπ-σ-ω (τύψω), the inflexion is supplied by the auxiliary verb *bhu*, to be, and *as*, to be, while the termination, which is pronominal, varies according to the person; amabo, amabis, amabit, &c. [GRAMMAR; FUTURE TENSE; IMPERFECT TENSE; &c.]

INFLEXION. In Optics, the same as *diffraction*; or that property of light by reason of which, when it passes very near the borders of an opaque body, it is turned from its rectilinear course. [DIFFRACTION and LIGHT.]

Inflexion, Point of. In Geometry, the point of contact of a stationary tangent; that is to say, a point at which the curve passes from one to the other side of its tangent, and towards which it always turns its convexity. It is sometimes called a point of contrary flexure. The points of inflexion of a curve are always situated on its Hessian, which is another curve of the $3(n-2)^{\text{th}}$ order, so that in general there are $3n(n-2)$ such points on a curve of the n^{th} order. Should the latter possess double points, however, this number will be diminished. [STATIONARY TANGENT and SINGULARITIES OF A CURVE.]

The term *point of inflexion*, in an extended sense, indicates any point at which the tangent meets the curve in an odd number of consecutive points, since under such circumstances the curve will always pass from one to the other side of the tangent. When the tangent has four or any higher *even* number of consecutive points in common with the curve, the latter does not pass to the other side, and the point is distinguished as a *point of undulation*.

Inflexional Tangents. In the theory of surfaces, the two lines, each of which, at their intersection, meets the surface in three consecutive points. They are imaginary, real, or coincident, according as the point is an elliptic, hyperbolic, or parabolic one. They coincide, in fact, with the asymptotes of the indicatrix, and each represents a pair of coincident conjugate tangents. [INDICATRIX.] The term *inflexional tangent* appears to have been first employed by Dr. Salmon in his *Analytical Geometry*, and was evidently suggested by the fact that each such tangent touches the section made by any plane through it at a point of inflexion. An inflexional tangent must be regarded as a *double tangent line* to the surface, since it joins the first to the

second, as well as the second to the third, of the three consecutive points coincident with that of contact. Through an arbitrary point in space there can in general be drawn $n(n-1)(n-2)$ inflexional tangents to a surface of the n^{th} order.

Inflorescence (Lat. inflorescere, *to begin to blossom*). The general arrangement of the flowers upon a stem or branch. It consists of the following principal kinds: viz. the spike, the raceme, the panicle, the capitulum, the umbel, and the cyme; each of which is mentioned in its place.

Influenza (as if produced by the *influence* of the stars). An epidemic *catarrh*, generally attended by languor, headache, quick pulse, and febrile symptoms, which often run very high, and assume a variety of aspects, dependent upon the season and other causes. The possibility of the existence of some highly poisonous and irritating vapour, though in very minute quantity, as the exciting cause of influenza, has been suggested by Dr. Prout. It may possibly be of volcanic origin; and such a substance as seleniuretted hydrogen, the effects of which, even in extremely minute quantity, are highly deleterious, might perhaps account for some of the phenomena of this extraordinary disease.

Information (Lat. informatio, *an outline* or *sketch*). In Law, an accusation exhibited against a defendant for some criminal offence, not on the oath of jurors, but on the special allegation of an officer empowered to exhibit it. Criminal informations are either partly at the suit of the king and partly at that of a subject, namely such as are brought upon certain penal statutes at the suit of common informers; or wholly at the suit of the king. These are of two sorts: 1. Those filed ex officio by the attorney-general—a proceeding resorted to in the case of some particular misdemeanours of a public nature, as libels and various other offences concerning the pub ic government; and 2. Informations filed at the suit of the master of the crown office, which lie for some gross and notorious misdemeanours, as riots, batteries, libels, &c., not immediately tending to disturb the government.

Informed Stars (Lat. Informes Stellæ). In Astronomy, stars not included in any of the constellations. [CONSTELLATION.]

Infralapsarians (Lat. infra, *below*, and lapsus, *a fall*). In Ecclesiastical History, a sect of Presbyterians who maintain that God has created a certain number of human beings only to be damned, without allowing them the opportunity of salvation even if they chose to embrace it. They are thus designated because they hold that the decrees of God were formed *infra lapsum*, after His knowledge of the fall, and in consequence of it. [SUPRALAPSARIANS.]

Infundibuliform (Lat. infundibulum, *a funnel*). A Botanical and Anatomical term, signifying *funnel-shaped*. The *infundibulum* of the brain is a canal proceeding from the lower and anterior part of the third ventricle of the brain to the pituitary gland.

Infusoria (Lat. infundo, *I pour in*). A name applied by Otto Fr. Müller to an assemblage of microscopic animalcules which are for the most part developed in infusions of decayed animal and vegetable substances. Some of these minute organised beings were known to Linnæus, and were placed by him at the end of the class *Vermes*, in a genus which he denominated *Chaos*. Müller, who made the Infusoria a subject of special study, discovered numerous distinct genera and species, which he named and classified according to their outward form. Gmelin and Lamarck introduced Müller's discoveries and classification of the Infusoria into their systems without any particular modification. Cuvier, in 1829, observes, that 'Naturalists usually close the catalogue of the animal kingdom with beings so extremely minute as to be invisible to the naked eye, and which have been discovered only since the invention of the microscope has unveiled to us, as it were, a new world. Most of them present a gelatinous body of the greatest simplicity, and for these this is undoubtedly the situation; but authors have placed among the Infusoria animals apparently much more complicated, and which only resemble them in their minuteness and the dwelling in which they are usually found.' These higher-organised Infusoria were placed by Cuvier at the head of the class in a distinct order, under the name of *Rotifera*, a name which has subsequently been retained. Cuvier attributes to these animalcules a mouth, a stomach, an intestine, and an anus; and notices the prominences on the anterior part of the body, which some observers had regarded as eyes. The anterior lobated organ and its vibratory denticulations, the successive action of which gives to the organ the appearance of a swiftly rotating wheel, forms the main external character of the order. Cuvier includes in the order *Rotatoria* the genera *Furcularia*, Lam.; *Vaginicola*, Lam.; *Tubicolaria*, Lam.; *Brachionus*, Müller.

The investigations of Ehrenberg, with the aid of a microscope superior to that of his predecessors, have brought to light many additional organs and complexities of structure in the *Rotifera*, besides several genera and species before unknown; and since these researches naturalists have generally regarded the *Rotifera* as a distinct class of Invertebrata, which Professor Grant has placed in the Articulate subkingdom, and Professor Owen in the *Nematoneura*, or higher division of Cuvier's Radiata. For the character, subdivision, and organisation of the ROTIFERA, see that word.

The second order of Infusoria in Cuvier's system is denominated *Homogenea*; a term sufficiently expressing the inadequate ideas current at that recent period respecting their organisation. Cuvier says, 'The body of the *Homogenea* presents neither viscera nor other complication, and is frequently destitute of even the appearance of a mouth.' Ehrenberg has since shown not only that they have really a mouth, but that the greater part of the

Homogenea of Cuvier possess a digestive cavity complicated with many cæcal cavities like stomachs; and accordingly proposes to name the order *Polygastrica*. True Infusoria of this class have, internally, a part called *nucleus* and a *contractile vesicle*; they are externally provided with vibratile cilia. Cuvier includes in his second order of Infusoria the genera *Urceolaria*, Lam.; *Trichoda, Leucophra, Kerona, Himantopus, Cercaria, Furcocerca, Vibrio, Proteus, Volvox*, and *Monas*. As the polygastric structure has not been detected in any species of *Cercaria*, but as, on the contrary, some species, as *Cercaria lemnæ*, possess a simple alimentary canal, this genus, together with the *Vibrionidæ*, which all possess a straight and simple alimentary canal, have been removed from the Infusoria, and classed by Professor Owen with the lower *Vermes*, including the Entozoa.

Thus the animals of infusions, although of comparatively simple organisation, yet manifest at least three distinct types of structure, and are referable to three different classes of animals; many, moreover, have been proved to be embryos of algæ.

Many genera of Infusoria are protected by an external silicious case. The observations which Ehrenberg had made on the modifications of the form and surface of these cases of the existing Infusoria led to his capital discovery of their remains in a fossilised state. The mineral called *Polier-scheifer*, used for a long period in the arts for polishing metals and other substances, was first discovered to be composed of myriads of the microscopic flinty cases of polygastric Infusoria belonging to the genera *Gaillonella, Bacillaria, Diatoma*, &c. Whole strata of considerable extent and thickness have since been found to consist almost exclusively of the fossil remains of Infusoria.

Inga (the South American name for one of the species). A Leguminous genus of South American trees belonging to the suborder *Cæsalpiniæ*. They have pinnated leaves, and in many cases handsome flowers. The white pulp contained in the pods of *I. Feuillei* is eaten in Peru, as is that of *I. spectabilis* and others in Panama; while that of the West Indian *I. vera* is purgative.

Ingluvies (Lat. *a crop*). The crop or dilatation of the œsophagus, in which the food is accumulated and macerated, but not digested. It is largest in the Gallinaceous birds and pigeons, but exists in certain birds of prey: also in the flamingo, and others.

Ingot. A word of doubtful origin, signifying chiefly the small masses or bars of gold and silver intended either for coining or exportation.

Ingrafting. [GRAFTING.]

Ingrailed. In Heraldry. [ENGRAILED.]

Ingrossing. [ENGROSSING; FORESTALLING.]

Inguinal (Lat. inguinalis, from inguen, *the groin*). Appertaining to or situated in or near the groin: as *inguinal artery, inguinal hernia*, &c.

Inhabitant (Lat. inhabitans, part. of inhabito, *I dwell in*). In Law, a word used in various technical senses. Thus a person having lands or tenements in his own possession is an inhabitant for the purpose of repair of bridges, wherever he may reside; but for purposes of personal service the *inhabitant* must necessarily be a resident. For the purpose of the poor rate, the word means a person residing permanently and sleeping in the parish. Where the right of voting was formerly in *inhabitant* householders, a variety of divisions in committees of the House of Commons, in some instances conflicting, took place on the point. But it appears to be generally understood that an inhabitant is one who keeps a house in his own occupation, either personally residing in it, or having it occupied by servants and ready for his residence; having what is termed the *animus revertendi*, or intention to return.

Inhalation (Lat. halo, *I breathe*). The drawing of air, gases, or vapours, into the lungs. Many substances are medicinally applied in this form, by means of an *inhaler*, an instrument so contrived as to admit of the inhalation of a variety of vapours mixed more or less with atmospheric air. The steam of hot water, the vapour of tar, of ether, of chloroform, of iodine, chlorine, &c. may be thus administered.

Inharmonical Relation. In Music, that in which a dissonant sound is introduced.

Inheritance (Lat. hæres, *an heir*). In Law, an estate or real property which a man has to himself and his heirs, or the heirs of his body, &c., is termed a freehold of inheritance. [FEE SIMPLE; FEE TAIL.]

Inheritance, Law of. In Physiology. The law by which individuals invariably, to a certain extent, transmit their forms and peculiarities to their offspring. The existence of this law has been impugned by Mr. Buckle, but it is satisfactorily borne out within certain limits by the phenomena known to stud-masters, sheep-farmers, and pigeon-fanciers, who are able to produce almost any form designed, within the limits of the specific characters of the individual. No satisfactory theory has yet been offered to physiologists to define which are the faculties transmitted by the male and the female parents respectively to their progeny. (Prosper Lucas, *Traité sur l'Hérédité.*)

Inhibition (Lat. inhibitio, from inhibeo, *I restrain*). In Ecclesiastical Law, a writ, commonly issuing out of a higher court Christian, to forbid an inferior judge from further proceeding in a cause before him; being analogous to a prohibition issuing out of one of the king's superior courts of justice.

INHIBITION. In Scottish Law, a species of diligence: i. e. process. It is a writ in the king's name, passing under the signet, whereby a debtor is prohibited from contracting any debt which may become a burden on his heritable property in competition with the creditor at whose instance the inhibition is taken out; and

from granting any deed of alienation, &c., to the prejudice of the creditor. The heir of the debtor is not affected by the inhibition of his ancestor. Other species of inhibition are, that of a husband against his wife, intended to signify that her superintendence over domestic affairs has ceased, on which his liability for domestic expenditure contracted by her also ceases; and inhibition of tithes or teinds.

Inis (perhaps from the same root with Gr. νῆσος, and Lat. insula, *an island*). An Irish word signifying island, used as a prefix to the names of some islands on the coast of Ireland, and of several towns situated on lakes or rivers in the same country; as Inisfallen, Iniskilling, &c.

Initial Velocity. The velocity of a projectile at the instant after leaving the muzzle of a gun. [GUNNERY.]

Initiative (Lat. initium, *a beginning*). In Politics. In legislative assemblies constituted so as to comprise more than one chamber, or more than one distinct and coordinate power, that branch of the legislature to which belongs of right the power to propose measures of a particular class is said to have the initiative with respect to those measures. Thus in England all propositions for taxing the subject, whether directly or indirectly, must begin in the Commons; a usage which has been adopted in most modern constitutions. On the other hand, there are some private bills which by custom originate in the Lords; and one bill, that, namely, for a general pardon, is proposed in the first instance by the crown. In France, by the charter of 1830, the three branches of the constitution enjoyed like privileges in proposing laws; but custom generally conceded the initiative to the Chamber of Peers, excepting in the case of money bills, which must, as in England, originate with the Chamber of Deputies; and the same principle is preserved in the modern legislature.

Injection (Lat. injectio, from injicio, *I cast in*). The process of introducing a jet of cold water into the condensing chamber of a low-pressure engine, for the purpose of hastening the production of a vacuum.

INJECTION. A liquid thrown into a cavity of the body by means of a bladder, syringe, or elastic bottle. Injections thrown into the rectum are called *enemata*, or *clysters* (from Gr. κλύζω, *I wash*).

Injunction (Lat. injunctio). In Law, a writ which issues under the seal of a court of equity. It is defined by Story, 'a judicial process, whereby a party is required to do or to refrain from doing a particular thing, according to the exigency of the writ,' granted in various cases, where the court thinks fit to interfere on equitable grounds with the acts of parties, or with the course of other jurisdictions. Thus injunctions are granted under certain circumstances to stay proceedings at common law; to restrain the negotiation of notes and other securities; to restrain parties from the commission of waste; to preserve property which is in course of litigation, &c. Injunctions are also granted to direct parties to quit possession of lands, &c. after a decree. Disobedience to an injunction is punishable as a contempt of the court from which it issues. By the Common Law Procedure Act, 1854, courts of common law were for the first time empowered to grant writs of injunction in certain cases.

Ink (Ger.; Dutch inkt; Fr. encre, perhaps from the Gr. ἔγκαυστον: Wedgwood, s.v.). The colouring matter of common writing ink is the tannogallate of iron, which is suspended in water by gum arabic; a little logwood is sometimes added to deepen and improve the colour. A good writing ink is made as follows: Take six ounces of finely bruised galls, four ounces of gum arabic, four ounces of green vitriol, and six pints of soft water. Boil the galls in the water; then add the other ingredients; and mixing the whole well together, keep it in a well-corked bottle, occasionally shaking it. In two months' time carefully pour off the ink from the residue into glass bottles, which should be well corked; a few cloves, or a drop or two of creasote, put into each bottle, prevent moulding. The addition of a little sugar to ink gives it a gloss, and prevents its drying rapidly and perfectly; so that it is generally used in what is called *copying ink*. *Indian ink* is a compound of very fine lampblack and size. It cannot, like common writing, be removed by acids; but as it does not bite or sink into the paper, it may generally be wiped off with a moist sponge. *Printing ink* is made with boiled linseed or nut oil and lampblack. *Red ink* is a solution of alum coloured with brazil wood. Boil two ounces of brazil wood, half an ounce of gum arabic, and a quarter of an ounce of alum in a pint of water for ten minutes; strain the decoction, and set it aside to clear. Ammoniacal solutions of cochineal are also used as *red inks*. *Sympathetic inks* are compounds which, when written with, will remain invisible till heated: solutions of cobalt thus become blue or green; lemon juice turns brown; and a very dilute sulphuric acid blackens. *Marking ink* is made as follows: Dissolve one drachm of lunar caustic (fused nitrate of silver) in half an ounce of water previously thickened with a little sap green: write with this upon the linen previously prepared for its reception by the application of a weak solution of carbonate of soda thickened with a little gum arabic, and suffered to dry upon the linen. A good marking ink requiring no preparatory application may be made as follows: Take nitrate of silver and bitartrate of potash, of each one ounce; solution of ammonia, four ounces; archil, half an ounce; honey, three drachms; compound tragacanth powder, one drachm and a half. Rub the nitrate of silver and the tartar together, and then add the other ingredients. Linen marked with this ink requires to have a hot iron passed over it; or the part marked may be held to the fire till the marks blacken. (Gray's *Supplement to the Pharmacopœia*.

Inland Seas. In various parts of the world there are large tracts of water enclosed or nearly enclosed by land, and only communicating with the sea by narrow channels called *straits.* When the communication with the ocean is somewhat wider than deserves the name of strait, the sea is generally called a GULF, and when very wide indeed it becomes a BAY. When the waters are so nearly enclosed as to communicate with the sea only by a river, they are called LAKES. [See those separate articles.]

Of all inland seas, properly so called, the MEDITERRANEAN is the most important, and the BALTIC comes next. The CARIBBEAN SEA is indeed larger than either, but it is less completely detached. All these are described separately. The BLACK SEA and the CASPIAN are remarkable, but the former is a sea within a sea, and the latter a lake. The Sea of Okhotsk, between North-eastern Asia and the Kurile Islands; the Sea of Japan, between the Asiatic coasts and the islands of Japan; the Yellow Sea and the China Sea, also on the same coast, are examples more or less striking of the same semi-enclosed pieces of water. The RED SEA is a singular strip of enclosed water, and is described in a separate article.

Innocents' Day. In the Calendar, a festival celebrated on the 28th of December, in commemoration of the infants stated in the Gospel of St. Matthew to have been murdered by Herod the Great.

Innominatum (Lat. in, neg., and nomen, *a name*; *without a name*). Each of the lateral bones of the pelvis is called *os innominatum*; because the three bones of which it consists originally, namely the *ischium*, the *ilium*, and the *pubis*, or the hip bone, the haunch bone, and the share bone, grow afterwards together so as to form what appears to be a single bone, which is thus left nameless.

Inns of Court. Four collegiate societies established in London. Every candidate for the rank of barrister-at-law is obliged to be admitted a member of one of these societies, and submit to its regulations as a student. These are: 1. The Inner Temple; 2. The Middle Temple; 3. Lincoln's Inn; 4. Gray's Inn. They are governed by BENCHERS. The *Inns of Chancery* (Clifford's, Lyons, Clement's, New, Furnival's, Thavies, Staples, and Barnard's Inns) were formerly subordinate societies depending on the Inns of Court, but this connection is now obsolete.

Innuendo (Lat. innuo, *I nod or beckon*). In Law. In the old Latin forms of pleadings this term was used as a word of reference, when in relating the words of another party it was necessary to describe more particularly the person or thing meant by that party; as, for instance, in a declaration in action for slander, which is the most ordinary modern case of the employment of the innuendo, the plaintiff avers that the defendant said that *he*, innuendo (meaning the plaintiff), was a thief, &c. Hence the use of the word, *an innuendo*, in ordinary language to signify a covert allusion.

Inocarpus (Gr. ἴς, ἰνός, *a fibre*, and καρπός, *fruit*). A Leguminous tree, belonging to the group *Cæsalpinieæ.* The seeds of *I. edulis* are eaten, and much prized by the natives of the Indian Archipelago; they are sweetish when boiled or roasted in ashes, but are not a very wholesome or palatable food.

Inoculation (Lat. in, and oculus, *an eye*). The introduction into the blood of a specific animal poison either by puncture or by contact with an already wounded surface. The term is generally used in reference to the variolous or smallpox poison. It is equally applicable, however, in speaking of the matter of glanders, or of that which occasionally enters the circulation owing to punctures received while dissecting the bodies of those who have perished from certain peculiar forms of disease. Inoculation by the vaccine virus is termed *vaccination.* It is said that inoculation by the smallpox virus was first practised by the Circassians, who adopted it as a means of preserving their women from the ravages of a disease so calculated to destroy beauty. Some believe that Lady Wortley Montague introduced inoculation into Britain from Turkey in 1721, her son having been inoculated at Constantinople

Much has been written on the advantages of inoculation as a means of preserving life. It has been calculated that in severe epidemics one-third of the adults attacked die, and one-seventh of the children; whereas, if inoculation be practised and the patient carefully treated, only 1 in 500 or 600 perish. Vaccination has now superseded inoculation; and the legislature is so persuaded of the advantages of the former, that inoculation is punishable by law, while vaccination is compulsory. [COWPOX; VACCINATION.]

Inoculation of Grass Lands. The ordinary method of turning a ploughed field into a meadow or pasture is by sowing it with grass seeds; but as this part of agriculture was formerly very ill understood, and the result of sowing grass seeds failed frequently to answer the expectations of the sower, the practice of what is called *inoculation* has of late years been invented, though practised but in very few instances. This consists in preparing the soil as if it were to be sown down with grass seeds; but instead of sowing these on the surface, there are distributed over it small fragments of turf taken from the best old pasture land which the neighbourhood affords. These fragments may be about two or three inches square, and they are laid down on the surface at the rate of about one in every square foot. After they are deposited, grass seeds, mixed with clover, are scattered over the surface, and the field is rolled to press down the turf and press in the seeds. In consequence of the fragments of turf being placed on fresh soil, the grasses, and other vegetables which they contain, if of the creeping kind, grow luxuriantly, and their stems cover the intervals between the fragments; but if the grasses

which the fragments contain should not be of the creeping or stoloniferous kinds, it is evident that the intervals between them must chiefly depend for their grassy surface on the seeds which have been sown. On the whole, the inoculation of grass land may be considered as a needlessly expensive process, unsuitable to the present advanced state of agriculture.

Inosculation (Lat. in, and osculatio, *a kissing*). The union of vessels by conjunction of their extremities. This term is sometimes limited to the communication of trunks or large vessels with each other; and where the ramifications which unite are small or capillary, the vessels are said to *anastomose*.

Inosic Acid. An acid found by Liebig in the juices of the flesh of animals.

Inquest (from Lat. inquiro, *I search into*). In Law, an inquisition of jurors in causes, civil or criminal, when the facts are referred to their trial, being impanelled by the sheriff for that purpose. Also the persons to whom the trial of fact in any question, civil or criminal, is committed. An inquest of office, or inquisition, is an inquiry made by the king's officer, sheriff, coroner, &c., by virtue of their office, or by writ sent them for that purpose, or by persons acting under a special commission, to inquire concerning any matter which entitles the king to the possession of lands and tenements, or goods and chattels; as forfeiture for offences, wreck, treasure-trove, &c. The king's title in general commences on office found, i. e. after the inquest has declared the results of its investigations.

Inquisition (Lat. inquisitio, *a seeking for*). The title given to a court armed with extensive criminal authority in various European countries; especially instituted to inquire into offences against the established religion. The first of these tribunals of faith was established in the south of France after the conquest of the Albigeois in the thirteenth century. They were established in Spain in the middle of the same century, not without much opposition on the part of the bishops and secular clergy, who, in Castile, long maintained their exclusive spiritual jurisdiction. In 1484, the supreme general inquisition was founded at Seville by Queen Isabella, with the aid of the Cardinal Pedro Gonzalez de Mendoza. This great court, commonly known by the name of the Holy Office, had far more extensive authority than those local tribunals of the same name, which had previously been established. Thomas de Torquemada, prior of a Dominican convent, was its first president, with the title of inquisitor-general. The process of the inquisition was widely different from that of all other courts of justice. The king named the grand inquisitor, who appointed his assessors, some of whom were secular, but the greater part regular ecclesiastics: the counsellors were six or seven in number, of whom one, by the ordinance of Philip III., must be a Dominican. A party who was brought under cognisance of the court by secret accusation was immediately seized by its officers (termed *officials* or *familiars*), and his property put under sequestration. If the accused was fortunate enough to absent himself, and did not appear at the third summons, he was excommunicated, and in some cases burnt in effigy. The subsequent process of the court by imprisonment, secret examination, and torture, is well known. Penitent offenders were subjected to imprisonment, scourging, confiscation, and legal infamy. Persons convicted and sentenced to death were burnt at the autos da fé, which usually took place on some Sunday between Trinity and Advent. According to a common calculation, 340,000 persons were punished by the inquisition from 1481 to 1808, of whom nearly 32,000 were burnt. In 1808 it was abolished by Napoleon. It was afterwards re-established by Ferdinand III. in 1814; but having been again abrogated by the cortes in 1820, it has not been since reconstituted. In Portugal, the supreme court of inquisition was established in 1557. Its history in many respects resembles that of the Spanish court; but in the eighteenth century its power was greatly curtailed by ordinances which required a certain degree of publicity in its procedure. It was abolished by the cortes of 1821. There were courts of inquisition in various southern provinces of France, the principal that of Languedoc, established at Toulouse, which was first founded after the war against the Albigeois; but their power was limited not long after their creation, and fell into desuetude long before their final abolition. At Rome the inquisition was only established in 1542 as a congregation of cardinals, styled *of the holy office*; but the other courts of inquisition throughout the Catholic world became subject to this body. Its authority was never recognised in France, and formally denied by arrêts du parlement in 1719 on the occasion of the constitution *Unigenitus*. In Italy itself the institution never took much hold on the manners or usages of the people. The court, however, subsists at Rome chiefly in practice for the correction of ecclesiastical delinquents, but its subjects of jurisdiction are legally deemed to be, heresy, blasphemy, polygamy, sacrilege, abuse of confession, false pretences to holiness, divination and sortilege, use of prohibited books, breach of the fasts of the church, &c.

Several well-known histories of the inquisition have been published, particularly that of Limborch. The reader may also consult Mosheim vol. iii.; Prescott's *Ferdinand and Isabella*; *Quart. Rev.* vol. lv.; Llorente's *Hist. of the Inquisition.*

Insanity (Lat. insanitas). Unsoundness of mind. This condition has been variously described, but no very satisfactory *definition* has yet been given, owing most probably to the fact that all the mental phenomena observed in the disease are to be detected in some degree in a vast number of persons who cannot be regarded as insane. When, however, we meet with one

in whom the powers of conception and of reasoning are very far removed from those of people in general, we must pronounce him insane, and this opinion will be further strengthened if with this perversion of conception and of reasoning power we can detect an uncontrollable violence of the emotional feelings, and, further, a perversion of the will, of the sensations, and of the instincts.

Pathologists and psychologists are now pretty well agreed that insanity is always connected either with some minute degeneration of brain structure, or with some still more obvious deviation from normal anatomy. Thus the relative weight of the cerebrum to the cerebellum has been shown to be less in the insane than in healthy persons. The specific gravity, too, of both the white and grey matter is increased in insanity. Again, it has been demonstrated that a very important change occurs in the substance of the brain, that a shrunken condition is gradually brought about, and that the nerve cells become degenerated, while inert matter is deposited, causing atrophy of the healthy structure. It is not possible to say more here on this very extended subject, than that the disorders of the mind have been classified variously according to the nature of the *mental* phenomena observed in the *propensities* which may have become over-excited. [LUNACY.]

Inscribed and Circumscribed Figures. In Geometry, when the angular points of one rectilineal figure are situated in the sides of a second, the former is said to be *inscribed in* the latter, and the latter to be *circumscribed to* the former. The same relative designations are employed when one of the figures is curvilinear, it being understood that when the inscribed figure is curvilinear it must *touch all the sides* of the rectilineal one. The inscription and circumscription of figures have occupied the attention of geometers since the earliest ages. Euclid devoted his fourth book to the subject [POLYGON], and some of the most important and remarkable of modern geometrical theorems and problems have a like origin. We need only cite as examples the well-known theorems of Pascal and Brianchon with respect to a conic and its inscribed and circumscribed hexagons, and the celebrated 'porism of the inscribed and circumscribed polygon,' according to which two conics may be so related that a polygon of a given number of sides may be inscribed in the one and circumscribed to the other, no matter at what point of the circumscribing conic the construction may commence. On this subject Fuss and Mention in the *Bull. de l'Acad. de St. Pét.*, Poncelet in his *Traité des Propriétés Projectives des Figures*, Steiner and Jacobi in Crelle's *Journal*, and Cayley in the *Phil. Trans.* and *Phil. Mag.* &c., as well as other writers, have published valuable researches.

Inscription (Lat. inscriptio). In Numismatics, words placed in the middle of the reverse side of some coins and medals. [NUMISMATICS.] For the value of inscriptions generally as historical documents, see HISTORICAL CREDIBILITY.

Insecta. [ENTOMOLOGY.]

Insectivora (Lat. insecta, *insects*, and voro, *I devour*). The name of an order of lissencephalous Mammals, comprehending those which have three kinds of teeth, and live wholly or chiefly on insects; also of an order of birds in the ornithological system of Temminck.

Inserted Column. In Architecture, a column standing or appearing to stand partly in a wall.

Insertion (Lat. insertio). In Botany, a term employed to denote the manner in which one part grows out of another. It was invented at a time when the laws of vegetable structure were unknown, and it was supposed that bodies which really grow from each other were inserted into each other. Thus stamens said to be inserted into a calyx are in reality stamens that adhere to the sides of a calyx.

INSERTION. In Printing, any new matter inserted in correcting proof sheets, the caret mark (∧) indicating where it is to go. If a compositor omits anything in setting, the matter omitted is called an *out*.

Insessores (Lat. from insideo, *I sit on*). A name by which Mr. Vigors has designated his second order of birds, including the *Passeres* and *Scansores* of Cuvier; and which C. Bonaparte applies to a primary division of birds in his *Systema Vertebratorum*, including the *Passeres*, *Scansores*, and *Accipitres* of Cuvier. As the term signifies those birds which perch, it is applicable to numerous species belonging to Linnæan and Cuvierian orders not yet included by later innovations under the term of Perchers or *Insessores*.

Inset or **Offcut.** In Printing, when some kinds of books, such as those in 12mo, 24mo, &c., are sent to the bookbinder and the sheets are folded, the offcut is put into the middle of the sheet to complete the succession of paging.

Insolation (Lat. sol, *the sun*) or **Scorching.** A local disease of plants, attributable to exposure to too bright a light, which causes an excessively rapid evaporation, the effect of which is to kill the part in which the evaporation takes place.

Insolinic Acid. A remarkably insoluble substance derived from cuminic acid by the prolonged action of chromic acid.

Insolvency (Lat. in, neg., and solvo, *I pay*). In Law, formerly, the inability of an individual not engaged in trade to pay his debts. The insolvency of a trader was called *bankruptcy*. In 1861 the consolidation of bankruptcy with insolvency was effected by statute. [BANKRUPTCY.]

Inspiration (Lat. inspiratio, from in, and spiro, *I breathe*). The act of drawing air into the lungs. [RESPIRATION.]

INSPIRATION. In Theology. [REVELATION.]

Installation (Low Lat. in, and stallum, *a seat*). A name applied to the ceremony of instating persons in honours or dignities; as a

Knight of the Garter in the chapel of St. George at Windsor; a chancellor in a university; or a dean, prebendary, or other ecclesiastical dignitary, in the stall of the cathedral to which he belongs.

Instant (Lat. instans, part. of insto, *I am present*). A part of time or duration in which no succession is perceived. There are three kinds of instants distinguished by the schoolmen; a *temporary*, a *natural*, and a *rational* instant. The first is a part of time immediately preceding another; the second is what is otherwise termed a *priority of nature*, which obtains in things subordinated in acting, as first and second causes, or causes and their effects; and the third is not any real instant, but a point which the understanding conceives to have existed before some other instant, founded on the nature of the things which caused it to be conceived.

Instantaneous Axis. In Mechanics, the locus of the points which at any instant are in a state of rest, when a body turns in any manner around a fixed point. [ROTATIONS, COMPOSITION AND RESOLUTION OF.]

Instantaneous Sliding Axis. In Mechanics, the right line along and around which a body moving with perfect freedom may, at any instant, be regarded as simultaneously sliding and rotating. It coincides with the so-called *central axis*. [ROTATIONS, COMPOSITION AND RESOLUTION OF.]

Instantiæ Crucis (Low Lat.). In Philosophy, *crucial* instances or examples; a phrase invented by the fancy of Bacon. The use of crucial examples or experiments is to facilitate the process of induction. For example, A and B, two different causes, may produce a certain number of similar effects; find some effect which the one produces and the other does not, and this will point out, as the direction-post at a point where two highways meet (crux), which of these causes may have been in operation in any particular instance. Thus, for example, many of the symptoms of the Oriental plague are common to other diseases; but when the observer discovers the peculiar *bubo* or boil of the complaint, he has an *instantia crucis*, which directs him immediately to its discovery. (See, amongst other commentaries on Bacon, Playfair's *Introd.* and *Edin. Rev.* vol. xxxvi.)

Instinct. [REASON.]

Institute (Lat. institutus, part. of instituo, *I appoint*). The principal philosophical and literary society of France, formed in 1795 by the union of four academies. [ACADEMY.] *Institute* is applied also to several works embodying the principles of Roman law; of these the chief are those of Justinian and Gaius.

Institution. In Ecclesiastical Law, otherwise called *investiture*, is the admission of a clerk to the church to which he has been presented by the ordinary (bishop, vicar-general, &c.). After institution the church is in contemplation of law *full*; but INDUCTION [which see] is required to give possession of the temporalities.

Institutions. In Literature, a term denoting originally a system of the elements or rules of any art or science, but signifying in a more comprehensive sense all associations formed for the improvement of society at large, or the parties immediately concerned.

Instruction, Criminal. In French Law, the technical term for the preliminary investigations and procedure at the trial of a criminal. Its management is intrusted to special officers, termed *juges d'instruction*.

Instrumental Case. In Grammar, the case which is used to express the instrument with which any act is performed. In Latin, the instrumental case is commonly called the *ablative*; in Greek it is termed the *dative*; but the two cases are really distinct. [LOCATIVE CASE.]

Instrumental Errors. Those errors which arise exclusively from want of mathematical accuracy in any instrument. Thus the flexure of a telescope tube induces an *instrumental error*.

Insulated (Lat. insulatus). In Architecture, a term meaning that the building to which it is applied is detached from any other. Thus, a church is said to be insulated when it adjoins no other building; as also a column is said to be insulated when standing out free from a wall.

Insulation. A body is said to be insulated which, containing a quantity of free caloric, or of the electric fluid, is surrounded by non-conductors, and the communication with other bodies thereby cut off.

Insulators. In Electricity, this term is synonymous with *non-conductors*. [ELECTRICITY.] The following substances are amongst the best insulators:—

Dry air.	Caoutchouc.
Shell lac.	Silk.
Sulphur.	Dry fur.
Resins.	Glass.
Gutta percha.	

Insurance. A contract of indemnity whereby the insurer, in consideration of a certain premium, undertakes to indemnify the insured against loss arising by the occurring of a contingent event; such as the destruction of houses by fire, the loss of ships at sea, the failure of crops through the inclemency of the seasons.

Insurance is sometimes synonymously used with *assurance*; but the latter term is now more frequently applied to one particular class of contracts, namely, those which depend on the continuance or failure of human life, while *insurance* is applied to risks of all other kinds. For the explanation of the principles on which life assurances are calculated, see ASSURANCE.

In all cases of insurance, the first thing to be determined is the degree of probability that the event under consideration will take place; but it seldom if ever happens that this is known with any moderate degree of precision. Even in the commonest cases, it is perhaps altogether impossible to procure the data necessary for the

accurate determination of this element. Suppose, for example, an insurance is to be effected on a ship bound on a voyage to China: in what manner is the probability of its reaching its destination in safety to be determined? Even if an accurate account had been kept of all the voyages made during a century, and the number of successful as well as the number of unsuccessful ones were precisely known, the data would still be very insufficient for determining the risk of the loss of any individual vessel. The loss of a ship is not a simple event like the turning up of a number on the face of a die. The greater or less prevalence of hurricanes at the season of the year when the voyage is to be made; the strength of the ship and sufficiency of its equipment; the skill of the commander, and the character and discipline of the crew—are all elements materially affecting the risk, but which it is impossible to reduce to numerical values and precise calculation. All, therefore, that can be done is to adopt certain mean or average values, deduced from observations of the fate of vessels in circumstances not indeed precisely the same, but having some degree of similarity. To the insurer, if he sufficiently multiplies his adventures, the result will be the same in the long run as if he had a more accurate appreciation of the separate influences of which the probability of the safe arrival of a vessel at a given port is composed; but the evil which results from this deficient knowledge of facts is, that the owner of a good ship, by paying the same premium for insurance as the owner of a bad one, is charged for indemnification against a risk which he really does not run; and hence the motives for improving the construction of vessels are not only destroyed, but it even becomes an object of pecuniary interest to expend in their equipment nothing beyond what is necessary to give them that moderate degree of goodness or seaworthiness which suffices to render them insurable on the ordinary terms. This system, however much it is to be deprecated, is rather advantageous than otherwise to the underwriters or insurers, because their premiums are charged in proportion, and it renders insurance more necessary. The pecuniary loss falls ultimately on the million who consume the merchandise; and as to the loss of human life, *that* consideration will probably operate as a check to cupidity only in so far as it may tend to raise the wages of seamen.

With respect to insurances against fire, the exact appreciation of the risk is not less difficult than in the case of marine insurances; but mathematical nicety on this subject is of little importance, for the amount of experience afforded by the general prevalence of the practice, and the competition which exists among the numerous rival companies, have probably had the effect of adjusting the premium to the average risk with all the accuracy which is practically attainable. The premium charged by the London offices for insuring property of the value of 100*l.* for a year is one shilling and sixpence, which corresponds to an average annual loss of nearly 1 in 1,300; but it is to be observed, that the sum which is charged as premium is presumed to be sufficient not only to cover the losses, but also to defray the expenses of the establishment, and to afford an adequate interest on the amount of the capital laid out or risked by the insurance company. Stamp duties on policies of sea insurance were reduced and fixed by 7 Vict. c. 21, in 1844, on a graduated scale, varying from 3*d.* to 4*s.* for each 100*l.* insured. Those on fire insurance have been reduced during the session of 1865.

The characteristic property of insurances, of whatever nature, is their tendency to reduce to a certain average value the profits or advantages arising from all speculations of the same kind, however great the number may be. The gain which the insurer makes on his successful speculations indemnifies him for his loss by those which are unsuccessful; and to the insured the result is the same as if they had paid their premiums into a common fund, and agreed to make good to each other their individual losses. The insurers are only the intermediate agents of this supposed association, and their profits may be regarded simply as the salary of their functions. If other means exist of dividing the risks, insurance becomes unnecessary. A mercantile company employing a very great number of ships, or taking part in a very great number of enterprises, would derive no benefit from insurance. The loss on those which are unsuccessful is compensated by the premiums saved on the whole; in fact, the company acts as insurer to itself. On this principle the government does not insure vessels belonging to the royal navy nor public buildings.

Intaglio (Ital.). The term applied to gem engraving when the subject is represented as being sunk below the level of the original surface; it is the contrary to *rilievo* or *alto rilievo*.

Integer (Lat. *whole*). In Arithmetic, a whole number as opposed to a fraction or mixed number. In general, the adjective *integral* is applied to quantities and functions to denote the absence of fractional forms. A *complex integer* in the theory of numbers is of the form $a+b\sqrt{-1}$, where a and b denote ordinary (real) integers. The theory of complex numbers was founded by Gauss in 1825 (*Theoria Resid. Biquadraticorum*); but the most lucid exposition of its elementary principles was given by Dirichlet in Crelle's *Journal*, vol. xxiv. The product a^2+b^2 of a complex number $a+b\sqrt{-1}$, and its *conjugate* $a-b\sqrt{-1}$ is called its *norm*, and denoted by either of the symbols

$$N(a+b\sqrt{-1}),\ N(a-b\sqrt{-1}).$$

The four *associated* numbers

$$a+b\sqrt{-1},\ a\sqrt{-1}-b,$$
$$-a-b\sqrt{-1},\ -a\sqrt{-1}+b,$$

as well as their respective conjugates, have all the same norm. A complex number is said to be *prime* when it admits of no divisors except itself, its associates, and the four *units*,

$$1, -1, \sqrt{-1}, -\sqrt{-1}.$$

Many of the higher arithmetical theorems, such as that of Fermat, may be extended to complex numbers.

Integral Calculus. The inverse of the differential calculus. All problems in integral calculus resolve themselves ultimately to the determination of the function which has a given differential coefficient; in other words, to the discovery of the function $F(x)$, which when submitted to the direct operation $\frac{d}{dx}$ yields the known result $F'(x)$. Thus

$$\left(\frac{d}{dx}\right)^{-1} F'(x)$$

is an appropriate symbol for $F(x)$. Another symbol for $F(x)$, however, is

$$\int F'(x)\,dx,$$

which denotes primarily the limit of the sum

$$\Sigma\{F'(x)\Delta x\},$$

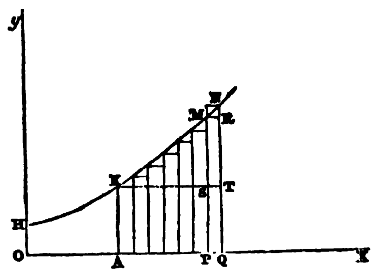
when Δx is allowed to diminish, and the number of terms added to increase in proportion. [INTEGRATION.] Such a limit is called an *indefinite integral*. The equivalence of the above two definitions of an integral may be rigorously established by a method similar to that noticed under INTEGRATION. The following geometrical illustration of this equivalence will here suffice, and will at the same time furnish an example of one of the many important applications of the integral calculus. Let $F(x)$ denote the plane area OPMH enclosed between a curve HM, two rectangular axes O X, O Y, and the ordinate MP, corresponding to any abscissa $OP=x$. Then if PQ be any constant increment Δx,

$$F(x+\Delta x)-F(x)$$

will clearly represent the area of the slice MPQN which, in magnitude, is intermediate between the rectangles RP and NP. Hence

$$\frac{F(x+\Delta x)-F(x)}{\Delta x}$$

will represent a *line* intermediate in length



between MP and NQ. Allowing Δx to diminish, therefore, we have MP = limit of

$$\frac{F(x+\Delta x)-F(x)}{\Delta x} = \frac{d}{dx}\cdot F(x) = F'(x);$$

so that the function whose differential coefficient represents the given ordinate MP of a curve, itself represents the area of that curve, or more strictly the area

$$F(x)-F(a)$$

of any portion APMK enclosed between the curve, the abscissa axis, and the initial and final ordinates

$$F'(a),\ F'(x),$$

corresponding to the abscissæ

$$OA=a \text{ and } OP=x.$$

But, extending the summation to all values of x between the same limits, the same area is clearly represented by the limit of the sum

$$\Sigma\{F'(x)\Delta x\}.$$

The latter is called a *definite integral*, having the *limits* a and x, and is denoted by

$$\int_a^x F'(x)\,dx;$$

its value, provided $F'(x)$ remains finite between the limits, is, as we have seen, equal to

$$F(x)-F(a),$$

where $F(x)$ is the function which, operated upon by $\frac{d}{dx}$, yields the given result $F'(x)$. With respect to the indefinite integral

$$\int F'(x)\,dx,$$

therefore, we have the symbol

$$\left(\frac{d}{dx}\right)^{-1} F'(x),$$

and the value $F(x)+C$, where C is a constant.

The subject of the integral calculus is far too wide to receive adequate exposition in such a work as the present; we shall, therefore, limit ourselves to brief definitions, in their proper places, of the principal technical terms employed therein, referring the student for further information to one of the many excellent treatises now within his reach. We may mention that those who are occupied with applications of the integral calculus will find the *Tables d'Intégrales Définies*, by D. Bierens de Haan, published by the Royal Academy of Sciences at Amsterdam, of great service. Another, older and less complete, but still useful, work of the same kind, is Minding's *Sammlung von Integraltafeln*, Berlin 1849.

Integral Multiple. [MULTIPLE, INTEGRAL.]

Integrals, Eulerian. [EULERIAN INTEGRALS and GAMMA-FUNCTION.]

Integrant Parts. In the CORPUSCULAR PHILOSOPHY [which see], the small parts of a body, by the aggregation of which it may be

conceived to be formed. *Integrant parts* result from the mechanical division of a body; *constituent parts* from its chemical decomposition.

Integrating Factor. In the integral calculus, a function of the variables which, when multiplied into every term of a differential equation, has the property of rendering the latter an *exact* differential equation. [DIFFERENTIAL EQUATION.] Every differential equation of the form $\mathrm{M}\,dx + \mathrm{N}\,dy = 0$, where M and N are given functions of x and y, has an infinite number of integrating factors. If μ be any one of them, however, all the rest are easily found; for if v be the function whose exact differential is $\mu\mathrm{M}\,dx + \mu\mathrm{N}\,dy$, then $\mu f(v)$, where f is an arbitrary functional symbol, will also be an integrating factor. These integrating factors are, indeed, particular integrals of a *partial* differential equation of the first order, for by their definition we must have

$$\frac{d(\mu\mathrm{N})}{dx} = \frac{d(\mu\mathrm{M})}{dy}$$

or $$\mathrm{N}\frac{d\mu}{dx} - \mathrm{M}\frac{du}{dy} = \left(\frac{d\mathrm{M}}{dy} - \frac{d\mathrm{N}}{dx}\right)\mu.$$

Now, this equation can only be solved in particular instances; its general solution, indeed, would require a previous knowledge of the general solution of the ordinary differential equation from which it was derived.

Similarly, if μ be an integrating factor of the ordinary differential equation

$$\mathrm{P}\,dx + \mathrm{Q}\,dy + \mathrm{R}\,dz = 0,$$

then the three conditions

$$\frac{d(\mu\mathrm{Q})}{dz} = \frac{d(\mu\mathrm{R})}{dy}, \quad \frac{d(\mu\mathrm{R})}{dx} = \frac{d(\mu\mathrm{P})}{dz},$$
$$\frac{d(\mu\mathrm{P})}{dy} = \frac{d(\mu\mathrm{Q})}{dx}$$

must be satisfied. By developing these equations, however, it will be found that their simultaneous satisfaction is possible only when

$$\mathrm{P}\left(\frac{d\mathrm{Q}}{dz} - \frac{d\mathrm{R}}{dy}\right) + \mathrm{Q}\left(\frac{d\mathrm{R}}{dx} - \frac{d\mathrm{P}}{dz}\right)$$
$$+ \mathrm{R}\left(\frac{d\mathrm{P}}{dy} - \frac{d\mathrm{Q}}{dx}\right) = 0 \cdot$$

is satisfied identically—a condition whose fulfilment indicates, conversely, that the proposed equation admits of a single primitive. Under ordinary circumstances, it may be added, the general solution of the equation under consideration consists of two simultaneous equations in x, y, and z, one of which is arbitrary in its form.

Integration. In ordinary acceptation, this term denotes the *summation* of any number of terms of a series whose law, or general term, is given. The operation of summation is denoted by the symbol Σ, prefixed to the general term; thus $\Sigma\,[\phi(t).\Delta t]$, where $\phi(t)$ is a given function, and Δt, the constant increment of its independent variable, indicates the summation of a number of terms, obtained by giving to t successive values, having the common difference Δt. According to this, Σ would appear to be the symbol of a direct and always possible operation; in reality, however, this is not the case; for, as we shall shortly see, the real object sought, the *integral*, is a function upon which the performance of a known direct operation leads to a given result. When the increment Δt is finite, the problem of summation falls within the scope of the calculus of differences, and the process which it involves is termed *finite integration.* When the increment Δt is allowed to diminish indefinitely, whilst the number of terms to be added is increased proportionally, the question arises as to what *limit* the sum will approach. The answer to this enquiry is furnished by the INTEGRAL CALCULUS [which see].

With respect to finite integration, it will be sufficient to consider the case where the increment $\Delta t = 1$. In fact, if $\Delta t = h$, we have merely to put $t = hx$, when we shall have $\Delta x = 1$, and, provided u_a be an initial value of the general term u_x of a series,

$$\Sigma u_x = u_{x-1} + u_{x-2} \cdot \cdot \cdot \cdot + u_a.$$

Putting $x + 1$ in place of x adds a term more to the series, so that the difference of the two sums is

$$\Delta(\Sigma u_x) = \Sigma u_{x+1} - \Sigma u_x = u^x,$$

and we see at once that Δ and Σ are *inverse symbols of operation*, in other words that Σu_x indicates the function which when operated upon by Δ yields the given result u_x. The symbol Σ, therefore, may be properly replaced by Δ^{-1}, and regarded as of an *interrogative* rather than of a *directive* character. Finite integration thus resolves itself into an *inverse method of differences*, the results of which are to be tested by the performance of the direct operation denoted by Δ. Hence if v_x denote a function whose difference is u_x, we shall have $\Sigma u_x = v_x + \mathrm{C}$, where C is an ordinary constant, or more generally a *periodical constant*, that is to say a function of x whose value remains unchanged when x is replaced by $x + 1$. The value of C in any actual summation depends obviously upon the initial term u_a, and may be found by putting $x = a + 1$.

An important class of rational functions may be integrated by means of the formula

$$\Sigma\,(ax + b)^{(m)} = \frac{(ax + b)^{(m+1)}}{a(m + 1)} + \mathrm{C},$$

which is true for negative as well as positive values of m, provided the definition of the factorial expression $(ax + b)^{(m)}$ be borne in mind. [FACTORIAL.] A useful formula for the integration of a rational and integral function of the n^{th} degree is also

$$\Sigma u_x = \mathrm{C} + x u_x - \frac{x^{(2)}}{\underline{2|}}\Delta u_x + \frac{x^{(3)}}{\underline{3|}}\Delta^2 u_x - \&c. \ldots$$

$$(-1)^n \frac{x^{(n+1)}}{\underline{n|}} \Delta^n u_x.$$

Another method of frequent application is that of *integration by parts*, according to the formula

$$\Sigma u_x \Delta v_x = u_x v_x - \Sigma v_{x+1} \Delta u_x,$$

which may be easily verified. Thus

$$\Sigma u_x a^x = u_x \frac{a^x}{a-1} - \Sigma \frac{a^{x+1}}{a-1} \Delta u_x,$$

so that if u_x is a rational and integral function of the n^{th} order, the integration of $u_x a^x$ may be effected by $n+1$ operations of the above kind. For works on finite integration, see DIFFERENCES, CALCULUS OF.

Integration by Parts. A method frequently employed with advantage in the integral calculus. The following formula, deducible at once from the well-known form of the differential of a product, viz.

$$d\,(uv) = udv + vdu,$$

will sufficiently explain the nature of the process:

$$\int udv = uv - \int vdu.$$

Integument. In Botany. [EPIDERMIS.]

Intellect. [UNDERSTANDING.]

Intendant (Lat. intendo, *I give my mind to anything*). A title in common use among the French, applied to persons who have the conduct, inspection, and management of any office or function; as intendants of the marine, of the finances, of provinces, buildings, houses, &c., which are all self-explanatory terms.

Intentions, First and Second. A distinction drawn by the schoolmen between those acts of thought which relate to an object out of the mind, and those which consist in the mind's reflex action on its own states of consciousness. Thus the generalisations *animal, production*, are *first intentions*: such terms as *abstraction, inference*, &c., are the expression of *second intentions*. It is to be regretted that this distinction is disused by modern enquirers, or misunderstood by them, as in particular by Whately. Great ambiguity might be avoided in philosophical language were it closely kept in view; as in such terms as *cause* and *effect*, which may either allude to a connection between natural phenomena in themselves, or to our mode of viewing them derived from the essential laws of the understanding. The distinction was first revived in the present century, in a learned and acute review of Whately's *Logic* (*Edinburgh Review*, No. 115).

Intercalary Day (Lat. intercalo, *I insert*). In the Calendar, a day inserted out of the usual order to preserve the account of time. Thus every fourth year containing 366 days, while the other years contain only 365, one of the months in that year must have an additional day, which is called the intercalary day. The additional day was given to February, as being the shortest month, and in the ancient Roman calendar was inserted between the 24th and 25th days. In the ecclesiastical calendar it still retains that place; but in the civil calendar it is the 29th. [BISSEXTILE; CALENDAR.]

Intercellular Passages. In Vegetable Anatomy, the spaces between the cells, tubes, or vessels of which the tissue of a plant consists. As the cells are usually, and the tubes or vessels always round, it necessarily follows that when pressed together there will be spaces left between their sides.

Intercept (Lat. interceptus, part. of intercipio). In Geometry, this term denotes the portion of any line intercepted between the intersections of the latter by other two lines, by a curve, by two planes, or by a surface. The intercepts made on the coordinate axes by any plane or line are the distances, with their proper signs, from the origin to the intersections of the axes by such a plane or line. The equation of a plane, expressed by means of such intercepts a, b, c, takes the very convenient form

$$\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1.$$

Intercolumniation (Lat. inter, *between*, and columna, *a column*). In Architecture, the space between two columns, measured at the lowest part of their shafts. It is one of the most important elements in a building, and on it depend the effect of the columns themselves, their proportion, and the harmony of an edifice. Intercolumniations are of five species, viz. ARÆOSTYLE; DIASTYLE; EUSTYLE; PYCNOSTYLE; and SYSTYLE [which see].

Intercostal (Lat. inter, and costa, *a rib*). In Anatomy, a designation of certain blood-vessels, nerves, and muscles, situated between the ribs.

Interdict (Lat. interdictum, from interdico, *I forbid*). In Ecclesiastical History, a spiritual weapon by which the popes used in former times to reduce individuals or whole states to the most abject submission. In the middle ages it was the most terrible blow which could be inflicted on the people or the prince. When an interdict was laid upon a kingdom, all spiritual services ceased; the churches were shut up; the sacraments were no longer administered; no corpses were buried with funeral rites; and all the ministry of the church, which was then believed to be the only channel of salvation, was forbidden to be exercised. The first memorable occasion on which this method of warfare was adopted was the marriage of King Robert of France with Bertha his cousin, when Gregory V. in 998 issued interdicts against the whole country, and compelled the sovereign to dissolve his union. It had, however, been often used before by bishops; an instance is quoted by Moreri as early as A.D. 870. (Gieseler's *Text-book* ii. 117, transl.) The ban under which England was laid in the reign of John by Innocent III. is well known in the history of this country. The latest pretensions to the exercise of this power were assumed by Pius VII. when he issued an inefficient decree against Napoleon in 1809.

Interdict. The technical term in Roman law for a decree of the prætor concerning the acquisition, retention, or recovery of property.

Interest. The premium or sum of money given for the loan or use of another sum of money, generally estimated at so much per cent., or per 100*l*. The sum lent, and for which the interest is paid, is called the *principal*, and the sum charged as interest is called the *rate*. The rate will evidently be proportional to the time; for whatever interest is paid for the use of 100*l*. for one year, twice that interest will be required for the use of 100*l*. for two years. The principal added to the interest, or the whole sum paid back to the lender, is called the *amount*.

Interest is either *simple* or *compound*. *Simple interest* is that which is reckoned and allowed upon the principal only during the whole time of the loan: *compound interest* is reckoned not only on the principal sum lent, but also on the interest as it becomes due.

All questions in simple interest may be solved by means of the easily demonstrated formula $a=p(1+rn)$, wherein a denotes the amount, p the principal, n the number of years, and r the rate of interest to be paid yearly for every pound lent. By this formula any one of the four quantities a, p, r, n can be at once calculated, when the remaining three are given.

Similarly, questions relating to compound interest may be solved by the formula $a=p(1+r)^n$, where the letters have the same signification as before. It will be observed that here certain questions can only be solved approximately. For instance, if it were required to find the number of years in which a sum of money would double itself, at 5 per cent. compound interest, we should have $a=2p$, $r=\cdot05$, hence $(1\cdot05)^n=2$; an exponential equation which solved, approximately, by logarithms gives

$$n=\frac{\log 2}{\log 1\cdot05}=\frac{3010300}{211893}=14\tfrac{1}{4} \text{ nearly.}$$

If the interest be payable m times a year, the value of money or *nominal* rate of interest being the same, the preceding formula would have to be replaced by

$$a=p\left(1+\frac{r}{m}\right)^{mn}.$$

Now when m increases indefinitely, the coefficient of p here is well known to approach the limit e^{nr}, where e is the base of the Napierian system of logarithms, i.e. approximately, 2·718281828. Hence we conclude that if interest were due *every* instant, the principal p would amount in n years to $a=pe^{nr}$. For instance, if money were worth 5 per cent. and interest were due every instant, 100*l*. would, in a year's time, amount to 100*l*. × $e^{\cdot05}$ = 105*l*. 2*s*. 6½*d*. nearly.

Interest. In Political Economy, the compensation made to lenders by borrowers, in consideration of the use and employment of their capital, has been defined by the late Mr. Senior as the wages of abstinence. It is clear that if an individual lends another a portion of his capital, he may not only expect to recover his loan, but is justified in demanding a certain recompense for surrendering to the profit of another that which he might have applied to his own advantage. Since, however, there is apparently no spontaneous increase in the advance made, many persons, not only in ancient times, but even to the present day, have censured the taking of interest as a wrong practised on society for the profit of those who possess money. So absurd a notion hardly deserves a serious answer; but it will be clear that a similar objection may be taken to the existence of rent, or even to profit of any kind. The advance, whatever it may be, is only under the form of money, and is practically a permission to use that claim upon his portion of collected wealth which the possessor of capital may make. If the capitalist sells his right to the portion to which he is entitled, and receives immediate payment for his property, it becomes the every-day transaction of a bargain. If, however, he postpones the acceptance of his price for the value which he transfers, i.e. makes a loan of the value which belongs to him, he is entitled also to the natural increase, that is to the market rate of profit on that which he advances, in other words he has a claim to interest. This rate is determined strictly by the principle of competition; the desire of the capitalist to employ his accumulations for profit, and the desire of borrowers to procure material on which to exercise their skill, diligence, and intelligence, being constantly present in civilised communities. When the capital to be invested is larger than the demand of borrowers, the rate of interest is low; when the demand of borrowers is greater than the amount of capital to be had, the rate is high.

From certain permanent fallacies which have in the infancy of economical science occupied even the ablest minds, and which are not extinct even at present, governments have constantly attempted to regulate rates of interest. This interference with the natural freedom of commercial action has occasionally been justified by a reference to the Mosaic prohibition of usury; but sometimes it is argued that lenders are unproductive consumers of part of the profit which is procured by labour. Such a notion, however, leaves out of sight the fact that production is impossible without capital, and that all capital is accumulated and employed with a view to profit. Again, it is alleged that if the trade in advances be not regulated by the authority of the legislature, borrowers are open to all the fraud and extortion of unprincipled lenders. But if by any injudicious enactments, or indeed by any enactments at all, the business of the lender is interfered with, it will not follow that borrowing will cease or even be diminished; but it will follow that the trade in loans will fall into less scrupulous hands; and it is certain in any case that the borrower will have to pay whatever additional charge may be imposed by the lender, in the event of

his reputation being diminished, his profits threatened, or his capital imperilled. All legislative enactments, therefore, the purpose of which has been to check or control the rates at which advances are made, have been accompanied by increased hardships on borrowers. It is of course the duty of governments to protect all persons against fraud and wrong, and even to annul the contracts of incapable persons. It may, perhaps (though it might be more difficult to vindicate such a position), be obligatory on governments to protect persons against their own folly; but it is utterly absurd for the legislature to affect the general regulation of contracts, and the prices at which services are appraised. It is as preposterous to attempt the direction of the price of money, as it is found to be to regulate the price of food; it is even more unwise, for evasions of such regulations are very easy and obvious to the lender, though, as has been said, exceedingly onerous, expensive, and mischievous to the borrower.

For rates of interest in Greece and Rome, the reader may be referred to Boeckh's *Public Economy of Athens*, and Niebuhr's *History of Rome*. We know from the New Testament that interest was paid on bankers' deposits in Judæa. In Europe it was alternately prohibited and permitted, the clergy being generally hostile to the practice. In the Italian republics, however, the trade in money was recognised and common. In 1546, it first received a parliamentary sanction in England, and was fixed at 10 per cent., but in 1552 was again prohibited. Mary, however, borrowed at 12 per cent., which appears to have been the usual rate at that period in Antwerp. In 1571, it was again made legal at 10 per cent., a rate at which the Scotch parliament fixed it in 1587. The rate fell at the beginning of the seventeenth century, James I. having borrowed in Denmark at 6. In 1624, it was reduced to 8; in 1651, to 6; in 1724, to 5, at which legal rate it remained till all usury laws were repealed, an event which occurred only a few years ago. In 1773, it was limited to 12 in India.

In 1660, according to Sir Josiah Child, the rate in Scotland and Ireland was from 10 to 12; in France 7; in Italy and Holland 3; in Spain from 10 to 12; in Turkey 20; but the East India Company, while the legal English rate was 6, contrived to borrow at 4.

Much of the misconception prevalent as to the nature of interest is due to the confused way in which the words *labour* and *profit* are used. Labour is generally limited to muscular exertion only, and profits are therefore often held to contain part of the wages or remuneration of labour. This confusion is particularly common in such cases as those in which the three objects in economical distribution, wages, profit, and rent, are united in the same person.

When advances are made at interest, and the true rate of interest is calculated from these advances, the corpus or principal must be supposed to be absolutely safe, and to be certainly replaced at the end of the period at which the advance is due to the lender. If it were possible that by the course of events in any particular case, the capital repaid would be more valuable at the period at which its replacement is due, than it is when the advance is made, the rate would fall below the market rate; if it were less in amount, it would be more. Thus, suppose an advance be made for joint-stock purposes, and it be seen in a short time that the property of the lender is more valuable than when it was first lent or advanced, the rate would rise, or, what is more familiar, the market value of the capital would be above par. If on the other hand the property is depreciated, the rate will fall, and the share be at a discount. It is true that advances of money to be paid in money will not, if the corpus be secured, fall in value, except to some extent and under certain circumstances, in bills of exchange; but in case any risk of the principal arises, the lender will require larger compensation proportionate to the risk, such larger compensation representing really a replacement of capital; and whenever monetary transactions are effected on a large scale, it can hardly fail but that some portion of this compensation for risk will fall on persons whose credit is quite unimpeachable. When, therefore, high interest is said to be synonymous with bad security, the expression means, that there is added to the interest another payment which virtually tends to replace capital, and that the whole mass of transactions must imply and contain an insurance to lenders. So, again, when advances are made for undertakings which terminate within a specified time, as leases of mines, where the apparent high rate of profit must be divided into two portions, one of which is the interest on the advance, the rate of which is regulated by the same competition as governs the rates of interest generally; the other, which is relative to the necessity of replacing that capital which is by the very terms of the lease extinguished at the conclusion of the time. It is important to recognise this distinction, because we shall find that by a negligent use of the word *profit* one of the elements in the rate of payment made on advances, and which is really the capital of the lender returned to him, or insured to him, by the natural operations of trade, is made the subject of taxation.

Similar to the condition, that, in order to determine the real rate of interest, the advance must be considered to be absolutely secured to the lender, is another, that the lender should exercise no care, supervision, or labour in the employment of the capital. But the word *profit* is frequently employed to denote the returns of the business, in which the greater part of the rate received and appropriated by the lender is to all intents and purposes the wages of labour. Now, it is essential for many purposes that several causes determining the equation of profits should be separated and distinguished.

For instance, suppose the rate of so-called

profit in any trade is 10 per cent.; that is to say, let us imagine that a trader has employed 10,000*l.* in business, and expects, and on the whole gets, 1,000*l.* annually clear upon the capital he has invested. The rate of interest on his capital is plainly determinable by several factors. We may take the rate of discount, and deriving an average from the duration of high and low rates, and if possible from the number of transactions negotiated at the several rates, supply one quantity from these considerations. Next, we may take the price of consols. Next, with some limitations, especially those which respect its political influence, and its prospective value, the rent of land. Finally, we may take mortgage rates, though as these are not readily transferable, some deduction must be made from their value, in consequence of the partial but mischievous effects of the stamp duties and other legal charges upon these transactions. The product may be easily arrived at, and say for the sake of illustration that the amount is 4 per cent. Next we take the element of risk, an element which is lessened in proportion to the breadth of the area on which transactions are negotiated, and to the number of the transactions themselves. And lastly we must reckon the wages of labour, wages not the less paid because the exertion is mental, and not the less real because they are not separated from the gross remuneration.

Interest should be distinguished from discount. The fluctuations of the rate in the latter are far more frequent and considerable than in the former. When advances are plentiful, the rate of discount is ordinarily lower than the rate of interest, because the advance is for a short period, and the capital lent is rapidly recovered. But when money is scarce, the rate is higher than that of interest, because every person who borrows pledges himself to meet his obligation in cash or its equivalent at a given time, and the supply falling short of the demand, or, what is the same thing, readiness to give credit being contracted, more persons are actively competing for a limited but necessary value. [DISCOUNT; PROFIT; USURY.]

Interference (Lat. inter, and fero, *I bring*). In Optics, a term first employed by Dr. Young to express certain phenomena which result from the mutual action of the rays of light on each other. The phenomena in question are considered of very great importance, and have accordingly been examined with great care, on account of the proof which they give of the truth of the undulatory theory of light.

It is well known that if two series of waves be produced upon a smooth surface of water, in such a manner that the two series will pass through each other: then, where the crests of two waves (one from each series) coincide, a wave of increased height will result; whilst in those places where the crest of a wave of one series coincides with the hollow of a wave from the other series, smooth water will result. Now, just as ripples are produced upon water by mechanical impact, so are waves or undulations created by a luminous body in the ether with which the universe is supposed to be pervaded: and it is these waves which, penetrating to the retina of the eye, produce the phenomena of vision.

If two series of these ethereal undulations intersect each other in such a manner that the crests of the waves of one series fall into the hollows of the waves of the other, the phenomenon termed *interference* is produced, and the two rays of light whose undulations thus neutralise each other are perfectly extinguished as regards luminous effect. This production of perfect darkness from two rays of light can, however, only occur when the light is monochromatic, since the ethereal waves producing the different colours of light possess different lengths, and consequently, if the waves of the two series are in such a relative position as to extinguish one of the colours of white light, then the remaining colours will not be affected; but as white light is composed of a number of pairs of colours which are complementary to each other, the mixture of each pair producing white light, it follows that no single colour can be thus extinguished without imparting to the residuary light the opposite or complementary colour. Thus the phenomenon of interference is attended, in the case of ordinary white light, with the most beautiful displays of colour, and some of the most magnificent colour effects in nature are thus produced. The colours of thin films of soap bubbles, or of oil upon water, the gorgeous tints of the humming bird, of the wing-cases of beetles, and of many shells, owe their origin to this cause. This interference between two rays of light can be produced in several ways; but as an illustration, it will suffice to describe the phenomenon as seen in the soap bubble.

Suppose a ray of light to fall upon the external surface of a soap bubble: the ray is divided into two parts, one of which is reflected or thrown back from the surface, whilst the other passes into the substance of the film and arrives at the inner surface of the latter, where it is again divided into a ray which emerges into the interior of the bubble, and another ray which is reflected back again towards the outer surface. A portion of the latter ray emerges from this outer surface, and mingles with the ray which is reflected on the first impact of the light upon the exterior surface of the bubble. Now, it is obvious that the two rays of light which are thus made to pursue the same path have not travelled the same distance; for whilst one has been reflected from the outer surface of the film, the other has twice crossed the substance of the film. The undulations of the latter are thus thrown behind those of the former, and to such an extent as to cause the crests of the waves of some one colour of the white light of one ray to fall into the hollows of the waves of the same coloured light in the other ray. Thus that particular colour is extinguished, whilst the residual light becomes tinted of the complementary colour. If inter-

ference has occurred with the blue rays, the residual light will be yellow. If the waves of yellow light have neutralised each other, a blue ray will result. The extinction of green produces crimson: that of crimson, green light; and so on. Now as the soap-bubble film varies in thickness, both in different parts at the same time, and in the same portion at different times, it follows that at almost any given moment each of these colours will be visible on different portions of the bubble, and that one and the same part of the bubble will continually change its hue as its thickness varies.

Interim (Lat. *in the mean time*). In modern European History, the name given to a decree of the emperor Charles V. (after the overthrow of the Protestant League of Smalcalde) in which he attempted to reduce to harmony the conflicting opinions of the Protestants and Romanists. The use of the cup, however, and the marriage of the clergy, were the only points which he conceded to the Reformers; and it became a question among them, and gave rise to many serious disputes, whether they could conscientiously submit even to a temporary decree of such a nature. The enactments of the *interim* were intended only to remain in force till some definitive settlement could be made; whence it derives the name by which it is generally known. It received the force of law at the diet of Augsburg, in 1548. Its provisions against the Protestants were, however, in most respects set aside by the treaty of Passau, 1552.

Interior Side. In Fortification, the line of the curtain produced from the centre of one bastion to that of the next.

Interior Slope. In Fortification, that part of the parapet sloping from the crest to the banquette; or that part of the rampart sloping from the terreplein to the natural level.

Interjection (Lat. interjectio, from jacio, *I cast*). In Grammar, a part of speech expressing simple emotion, without involving any act of conception. [GRAMMAR.]

Interlocutor (Lat. inter, and loquor, *I speak*). In Literary phraseology, a person who is introduced as taking part in a dialogue; in Dramatic Literature, termed *dramatis persona*: the latter name, however, comprehends such as appear on the stage, but take no part in speaking, termed by the Greeks κωφὰ πρόσωπα, *mute personages*.

Interlocutory Judgments. In Law, such as are given in the course of a cause upon any proceeding arising out of it, and do not finally determine it: as, the judgment in an action of damages upon which a writ of enquiry issues to assess such damages. So a decree in chancery is either final or interlocutory. In Scottish law, a judgment of the court of session, or lord in ordinary, which, if allowed to become final, will be conclusive, is termed *interlocutor*.

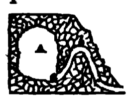
Interlude (Lat. inter, and ludo, *I play*). A short dramatic piece, generally accompanied with music; properly, such as is represented or performed between the acts of longer performances.

Intermede or **Intermezzo** (Ital.). In Dramatic Literature, nearly the same with *interlude*. A short musical piece, generally of a burlesque character; but many pieces not intended merely for introduction between the acts of a more serious performance are comprised under these names by the French and Italians.

Intermediate Shaft. In Marine Engineering, the term *intermediate shaft* is applied to the strong shaft that runs across the frame of the engines, to connect the two engines and the two paddle-wheels.

Intermittent (Lat. intermitto, *I leave off*). Any disease which ceases for a time and again returns, so that the patient is free from it in the intermediate intervals. [AGUE.]

Intermitting Springs. Springs which, after having run for a certain time, stop altogether, and after a time begin to run again, and then stop, and so on alternately; the flowings and intermissions generally succeeding each other at pretty regular intervals. These phenomena, which have sometimes been ascribed to the influence of witchcraft, are explained on the principle of the siphon. Let A be a cavern in a mountain, and *abc* a channel communicating with A, and terminating on the side of the mountain or adjacent plain; and let us suppose the



cavern to be fed by small streamlets of water, of which the united supply is less than can be discharged by the channel *abc*. Let the cavern be supposed empty. The water from the rills or fissures by which it is fed will collect at the bottom, and as it rises in the cavern will also rise in the channel *ab* till it reaches the highest level *b*, when it will begin to flow out through *bc*, and by the property of the siphon will continue to flow till the whole cavern is drained to the level of *a*. The cavern then begins to fill anew, and the same series of phenomena is repeated at intervals, of which the length depends on the relative capacity of the cavern and channel, and the abundance of the supply through the fissures. When the supply is constant, the intervals of intermission will be equal. Some springs of this kind do not cease altogether to flow, but only discharge a much smaller quantity for a certain time, and then a greater quantity. In this case they are called *variable* or *reciprocating* springs. They may be caused by the circumstance of a smaller fissure connecting the cavern with the lower part of the channel *c*, through which a portion of water continues to flow while the main discharge is stopped; or there may be several siphons all communicating with a common outlet. It is easy to imagine a combination of circumstances by which the discharge of water will be greatly increased by the elastic force of air compressed at the top of the cavern A. This will take place when the fissures which communicate with the external atmosphere are filled with

water, and there is in consequence no opening by which the air in the cavern can escape. An interesting example of one of these springs may be seen at the village of Giggleswick, near Skipton, in Yorkshire. A powerful rush of water issues from this spring at intervals, varying from five minutes to one hour, according to the wetness or dryness of the season.

Intermodillion. In Architecture, the space between two modillions, which is the same throughout the entablature.

International. That which relates to transactions between independent nations, acknowledging no common superior. In this sense we speak of *international law* as an important branch of the so-called LAW OF NATIONS [which see], and *international copyright* [COPYRIGHT]. It may be expedient to lay down a caution against an incorrect use of the word which has of late arisen, namely, in the sense of 'common to' all or several nations: e.g. an *International Exhibition of Industry*.

Internode (Lat. inter, and nodus, *a knot*). In Botany, the space that intervenes upon a branch between the leaves.

Internuncius or Internuncio (Lat.). An envoy of the Pope, sent to small states and republics; distinguished from the nuncio, who represents the Pope at the courts of emperors and kings. Also a species of diplomatic officers, who ranked, according to the old practice, between ambassadors and plenipotentiaries. Since the congress of Vienna, in the rules of which no mention is made of internuncios, they are considered on a level with plenipotentiaries. This is (or lately was) the title of the Austrian envoy at Constantinople.

Interosseous Muscles. Small muscles between the metacarpal bones of the hand and the metatarsal of the foot: the former are concerned in moving the fingers, and the latter the toes.

Interparietal (Lat. inter, and paries, *a wall*). In the early Aymará or Peruvian races, the skulls of which have been found at the borders of Lake Titicaca, a supposed peculiar configuration was observed by Dr. Bellamy and Professor Tschudi, viz. the separation during life of the upper half of the superoccipital, a presumed embryonic character persistent in some lower animals. This anomaly has been observed in individuals of most races.

Interpilaster. In Architecture, the space between two pilasters, which depends upon the same rules as the intercolumniation, more especially if both be employed in the same building.

Interpleader. In Law. A bill of interpleader, in equity, is filed by a person who is under an obligation or the like to one of two parties, but cannot ascertain to which of the parties he is indebted, and by his bill he calls upon the parties to interplead, and settle their claims between themselves, in order that he may bear himself harmless in the event of the success of either party. In the common law courts, by 1 & 2 Wm. IV. c. 58, relief can be given in some cases against adverse claims made on sheriffs and other officers, and persons having no interest in the subject of such claims, by a judge's order calling on the third party to appear and maintain or relinquish his claim.

Interpolation (Lat. interpolatio). Mathematically considered, the general problem of interpolation may be thus stated: Given a number of particular values of a function, to find its general value. If the *form* of the function were known, and the data sufficiently numerous, the problem would, of course, be a perfectly determinate one, and capable of easy solution. Usually, however, this is not the case.

In Astronomy and Physics, for instance, interpolation usually signifies the method of finding a mathematical law which will connect together a number of observed facts. Thus, supposing twenty places of a comet have been determined by observation; these places are said to be interpolated when a curve defined by an analytical equation has been found which passes through them all, for by means of this curve the place of the comet at any intermediate time can be found. According to this view of the subject, the problem of interpolation is altogether indeterminate; for an infinity of curves of different forms may be found which will pass through twenty given points; but in general the circumstances of the question impose such restrictions as render it determinate. In the instance now given we know that the curve must be an ellipse; and as an ellipse cannot be made to pass through twenty points taken anyhow, the question resolves itself into this: To find the ellipse which will *most nearly* pass through the given points, or represent the given observations. Another question now arises, What condition must be fulfilled in order that the observations may be represented *most nearly*? This condition must be determined from other considerations. Suppose the condition to be that the sum of the squares of the errors of observation (that is, of the differences between the observed places of the comet and the corresponding places in the orbit to be found) shall be a minimum; the problem is now quite determinate, though its solution may be sufficiently difficult and laborious.

Most frequently the form of the function, some of whose particular values are given, is assumed to be algebraic, rational, and integral; and the problem of interpolation, geometrically expressed, resolves itself to finding the parabola

$$y = A_0 + A_1 x + A_2 x^2 + \ . \ . \ . \ + A_{n-1} x^{n-1}$$

of the highest possible order, which shall pass through a given number of points. If n particular values are known, the order of this parabola will obviously be $n-1$, since in its equation, as above written, there are n constants to be determined. When the given values of y are *equidistant*, in other words correspond to

equidifferent values of x, the calculus of differences furnishes at once the required formula for interpolation. Taking the first ordinate as ordinate axes, and the common difference of the successive abscissæ as unit, we have

$$y=y_0+x\Delta y_0+\frac{x(x-1)}{1.2}\Delta^2 y_0 \text{ \&c. . .}$$
$$+\frac{x(x-1)\ .\ .\ .\ (x-n+2)}{1.2\ .\ .\ .(n-1)}\Delta^{n-1}y_0,$$

where y_0 represents the first ordinate, corresponding to $x=0$, and Δy_0, $\Delta^2 y_0$ &c. . . . the successive differences of the given series

$$y_0, y_1, y_2, \ .\ .\ .\ y_n.$$

The n^{th} difference $\Delta^n y_0$ vanishes, of course, in consequence of the assumed form of the function y.

When the given values of y are not equidistant, but correspond to the values a_1, a_2, . . . a_n, of x, then it is best to assume, instead of the above, the equivalent form

$$y=A_1(x-a_2)(x-a_3)\ .\ .\ .\ (x-a_n)$$
$$+A_2(x_2-a_1)(x-a_3)\ .\ .\ .\ (x-a_n)+\ .\ .\ .$$
$$+A_n(x-a_1)(x-a_2)\ .\ .\ .\ (x-a_{n-1}),$$

which is readily seen to be of the $(n-1)^{\text{th}}$ degree. Putting $x=a_m$, and calling y_m the given corresponding value of y, we have obviously the general formula

$$A_m=\frac{y}{(a_m-a_1)\ .\ .\ .\ (a_m-a_n)},$$

since all terms except the m^{th}, which does not contain $(x-a_m)$, vanish.

The value of y, therefore, may be conveniently expressed in the form

$$y=\sum_{m=1}\frac{(x-a_1)\ .\ .\ .\ (x-a_n)}{(a_m-a_1)\ .\ \ .\ (a_m-a_n)}y_m.$$

The method of interpolation by differences was first employed by Briggs in the calculation of logarithms; but was afterwards treated in a more general way by Wallis, Newton, Cotes, Stirling, and others. In the fifth lemma of the third book of the *Principia*, Newton has given a solution of the problem of determining the curve which passes through the extremities of any number of ordinates. By modern writers the subject is usually treated as a branch of the calculus of finite differences. It is discussed at length by Laplace in vol. ii. of the *Mécanique Céleste*, and also in the *Théorie Analytique des Probabilités*; by Lagrange, in the *Journal de l'École Polytechnique*, &c. See also the 'Treatise on Differences and Series' by Sir John Herschel in the Appendix to the English translation of Lacroix's *Differential and Integral Calculus*, or vol. iii. of Lacroix's large *Treatise*, or lastly Boole's useful little *Treatise on the Calculus of Finite Differences*. Amongst the most recent researches on Interpolation, we may mention those of Tchebichef, *Pétersbourg Acad. Bull.* 16, 1859; Hermite, *Comptes Rendus* t. xlviii. 1860, and Borchardt, *Abhand. der K. Akad. der Wissen. zu Berlin*, 1860.

Interregnum (Lat.). The period between the death of one king and the accession of another under the Roman monarchy, which is represented as elective; or under the republic, the space of time when there were by some accident no curule magistrates who could hold the public assemblies of the people (comitia), and during which, therefore, an interrex was appointed. There can be legally no *interregnum* in an hereditary monarchy like that of England; hence the reign of Charles II. was always computed in legal language as commencing at the execution of Charles I.

Interrex (Lat.). A person appointed to discharge the royal functions during a vacancy of the throne. According to their legendary history, the Romans first elected an interrex after the death of Romulus, and continued the custom while the monarchy lasted. The manner of their election was said to be this: the senate chose ten individuals out of its body, each of whom discharged the function of royalty for five days in an order appointed by lot. It has been supposed that these ten senators were not elected, but were the respective seniors of the ten decuries into which the original body of patricians was divided, and that this office devolved on them by virtue of their rank; but the utter uncertainty of this and other subjects in Roman tradition has been pointed out by Sir G. C. Lewis, *Credibility of Early Roman History*. An interrex was also appointed sometimes under the republic to preside over elections of magistrates, &c. when the consuls were absent, or their election declared void and no dictator had been created.

Interrogatories (Lat. interrogo, *I question*). In Law, written questions, proposed to witnesses who are to be examined out of court, under authority of courts where such examination is not directed to be taken vivâ voce. In equity pleading, interrogatories may be served by the plaintiff upon the defendant to be dealt with by him in his answer, and vice versâ. Under the Common Law Procedure Act, 1854, parties to actions and common law had for the first time the power of procuring, by means of interrogatories, statements relevant to the questions at issue.

Interscendent (Lat. inter, and scando, *I climb*). In Algebra, a term applied by Leibnitz to quantities when the exponents of their powers are irrational. Such expressions are called *interscendent*, as holding a mean as it were between algebraic and transcendental quantities.

Intersection (Lat. intersectio, from seco, *I cut*). In Geometry, the meeting or concourse of lines and surfaces. The number of intersections of a plane curve with a right line determines the *order* of that curve, and hence it follows that, in general, the number of intersections of two plane curves is equal to the product of their orders. The order of a surface is the number of real and imaginary intersections which it makes with a right line, and hence agrees with the order of each of its plane sections. As a consequence, the number of

points in which three surfaces intersect will be equal to the product of their several orders. The order of a non-plane curve is determined by the number of its intersections with any plane, whence it follows that the order of the curve in which two surfaces intersect will be equal to the product of the orders of the intersecting surfaces, and further that the product of the orders of a surface and a non-plane curve will give the number of their intersections. It is on these principles that algebraic curves and surfaces are classified.

Intertie. In Architecture, a horizontal piece of timber framed between two points, in order to tie them together; sometimes this is called a *cross-brace.*

Interval (Lat. intervallum). In Military language, the space between two portions of a body of troops in line, as distinguished from *distance*, the space between troops in column.

INTERVAL. In Music, the imaginary distance between two sounds as respects their acuteness and gravity; thus, for instance, the imaginary distance from C upwards to D is called the interval of a tone; from C to E the interval of a major third; from C to G the interval of a fifth, and so on.

Intervention (Lat. interventio, *a coming between*). In Politics, the interposition of one state in the domestic affairs of another. The right of armed intervention is one of the most contested portions of the public law of nations; as, although practised frequently enough by the more powerful with reference to the weak, it had never been regarded otherwise than as a permitted abuse of power until the time of the congresses of Vienna, Laybach, &c., when it was publicly recognised by the leading cabinets of Europe. The principle on which this supposed right was rested was indeed that of self-defence, in suppressing principles and practices by the prevalence of which the internal peace of the intervening state was threatened. Such was the ground on which France asserted her right to intervene by arms in the political affairs of Spain in 1821, which led to much discussion, and to the strong reprobation of the alleged right on the part of British statesmen. The history of Italy from 1821 to 1849 afforded little else than a series of such *interventions*, chiefly on the part of Austria, to prevent the spread of liberal politics in portions of the peninsula not under her government. The *intervention* of the allied powers between Greece and Turkey in 1827 was based on motives of humanity. But the most remarkable instance of recent time was that of Russia, between the government of Austria and Hungary, in 1849; for which little or no reason could be assigned except the possible danger of an insurrection in Poland following the achievement of Hungarian independence. Generally speaking, it may be said that *interventions* on the ground of apprehended necessity will never cease; but that all endeavours to erect them into a branch of international law or usage are futile.

Intestacy (Lat. intestatus, *that has made no will*). In Law, the condition of a party who dies without having made a will. Freehold lands and tenements in which he has an estate of inheritance descend to his heir, subject to such charges as affect real estate; copyhold lands of inheritance to the heir, by the custom of the manor; chattels must be distributed (subject to debts) by the party who takes out letters of administration to the estate and effects of the deceased, according to the provisions of the Statute of Distributions.

Intestinalia, Intestinal Worms (Lat. intestinus, *internal*). The name by which Linnæus and Cuvier have designated the class of animals which infest the interior of other animal bodies, and which indicates their most common locality, viz. the intestinal tube.

The knowledge of the intestinal worms, as a distinct class of invertebrate animals, is of a very late date. In the twelfth edition of the *Systema Naturæ*, 1787–8, only eleven species of true Entozoa are enumerated, and of these only six are placed among the *Intestina*—*Gordius medinensis*, *Ascaris vermicularis*, *Ascaris lumbricoides*, *Fasciola hepatica*, *Fas. intestinalis*, and *Fas. barbata*; the remaining species, viz. *Hydra hydatula*, *Tænia Solium*, *Tæn. vulgaris*, *Tæn. lata*, and *Tæn. canina*, are ranged with the Zoophyta. Bloch's *Treatise on the Generation of Intestinal Worms*, and the succeeding work of Göze, entitled *Versuch einer Naturgeschichte der Eingeweidewürmer Thierischer Körper*, 1782, added largely to the number of the described species, and led to the foundation of some accurately defined groups, and to better ideas of classification. The first clear definition of the intestinal worms as a class, and their distribution into a system of orders and generas, are contained in the great work by Rudolphi, entitled *Entozoorum seu Vermium Intestinalium Historia Naturalis*, 8vo. 1808–10. In this work, Rudolphi, after dividing the great class *Vermes* of Linnæus into four classes, viz. *Mollusca*, *Gymnodela*, *Entozoa*, and *Phytozoa*, characterises the third class as follows: 'Entozoa ergo classem, aut si mavis ordinem, sistunt peculiarem continentem, *aliis in animalibus obvia, oculis nudis conspicua, nervis carentia, partibus internis dissimilibus instructa.*' Of the class of animals thus characterised, Rudolphi enumerates, in a subsequent work, *Synopsis Entozoorum*, 1819, upwards of 1,100 species. At the present time, nearly double that number of Entozoa are known.

Rudolphi distributes the intestinal worms into five orders, which are characterised as follows:—

Order I. *Nematoidea* (Round-worms).—Char.: Body elongated, rounded, elastic; an intestinal canal, with a separate mouth and vent; sexes distinct.

Order II. *Acanthocephala* (Hooked-worms).—Char.: Body roundish, utricular, elastic; head with a retractile proboscis, armed with hooks or recurved spines; sexes distinct.

Order III. *Trematoda* (Fluke-worms).—Char.: Body soft, rounded, or flattened; suctorial pores; male and female organs in the same individual.

Order IV. *Cestoidea* (Tape-worms).—Char.: Body elongated, flattened, soft, continuous, or articulated; head either simply labiated, or provided with pits (*bothria*), or suctorious; orifices, either two or four in number; male and female organs in the same individual.

Order V. *Cystica* (Hydatids).—Char.: Body flattened or rounded, continued posteriorly into a cyst, which is sometimes common to many individuals; head provided with two or four pits, or with four suckers, and with a circle of hooklets, or with four unarmed or uncinated tentacles; sexual organs hitherto indiscernible.

The Entozoa which are included in the last four orders of Rudolphi have no distinct intestinal canal; and Cuvier considered the presence of this structure in the *Nematoidea* of Rudolphi of sufficient importance to form the character of a primary group, equivalent to all the remaining orders combined; and he observes that the orders thus distinguished might form two classes.

The first order Cuvier terms *Cavitaires*; and he includes in it not only the Nematoid Entozoa, but also the genus *Pentastoma* of Rudolphi, and the Epizoa, or *Vers rigidules* of Lamarck.

The organisation of the *Pentastomata*, which were defined, prior to Rudolphi, by Froelich, under the name of *Linguatula*, entitles them to rank with the highest organised Entozoa (*Zoological Trans.* vol. i. p. 381, pl. 41); but, with respect to the Epizoa, or the external Lernæan parasites of fishes, although they agree with the *Nematoidea* and all other Entozoa in the absence of distinct respiratory organs, yet the ciliated natatory extremities which they possess in the young state, and the external ovarian appendages of the adult, are characters which raise them above the Entozoa, and indicate their intimate relations with the Siphonostomous Crustaceans.

Professor Owen has, therefore, combined the *Nematoidea* of Rudolphi with the genera *Linguatula*, *Porocephalus*, and *Syngamus*, &c., which, under the habit of Cestoid or Trematode worms, mask a higher grade of organisation, to form a class under the name of *Cœlelmintha*. This class already embraces the types of three different orders, of which one is formed by the *Nematoidea* of Rudolphi; and a second has been established by Diesing, for the *Linguatula*, and other congeneric species, under the name of *Acanthotheca*. The remarkable organisation of the genus *Syngamus*, as described by Siebold, clearly indicates the type of a third order of CŒLELMINTHA [see that word].

The four orders of intestinal worms which have no distinct intestine, but in which the digestive function is carried on in blind canals, excavated in the parenchymatous substance of the body, Cuvier combines into a group, which he terms *Vers intestinaux parenchymateux*, and for which Prof. Owen has proposed the name of STERELMINTHA [see that word].

This group Cuvier subdivides into three families, or orders; the first corresponding to the *Acanthocephala* of Rudolphi, the second to the *Trematoda*, and the third being equivalent to the *Cestoidea* and *Cystica* combined; with the exception of the genus *Ligula* of Bloch, of which Cuvier makes a fourth order, restricting to it the application of Rudolphi's term *Cestoidea*. To this distinction it must be objected that the passage from the *Tæniæ* to the *Ligulæ* is rendered very gradual by the traces of bothria and of generative organs, which make their appearance in the higher organised *Ligulæ* which infest the intestines of certain aquatic birds, and respecting which Rudolphi hazarded the hypothesis, viz. that these species are actually the more simple *Ligulæ* of fishes, developed into a higher grade of organisation by virtue of the warmth and abundant nutriment which they enjoy in the intestines of the birds that have swallowed the fishes so infested. Such migrations have since been experimentally proved in regard to many *Intestinalia*; especially in reference to the *Cystica*, Rud., which become *Cestoidea* when introduced into other animals, as, e.g., from the flesh of prey into the gut of the devourer. The *Cystica* are, in fact, incompletely developed *Cestoidea*.

Thus the intestinal worms, as at present known, form two classes, each divisible into three orders.

Class I. CŒLELMINTHA.

Order 1. *Nematoidea*.—Ex.: *Filaria medinensis*, *Fil. oculi*, *Fil. bronchialis*, *Ascaris lumbricoides*, *Asc. vermicularis*, *Trichocephalus dispar*, *Spiroptera hominis*. *Strongylus gigas*, *Strong. spiniger*: the *Trichina spiralis* is a larval Nematoid, which acquires fully developed sexual organs when received into the intestinal canal, whence the progeny migrate to the muscular tissue.

Order 2. *Acanthotheca*.—Ex.: *Linguatula tænioides*.

Order 3. *Syngamoidea*.—Ex.: *Syngamus trachealis*.

Class II. STERELMINTHA.

Order 1. *Acanthocephala*.—Ex.: *Echinorhynchus gigas*.

Order 2. *Trematoda*.—Ex.: *Distoma hepaticum*, *Polystoma pinguicola*, *Planaria*.

Order 3. *Tænioidea*.—Ex.: *Bothriocephalus latus*, *Tænia Solium*: the *Cysticercus cellulosæ* and *Echinococcus hominis* are larval states.

The examples quoted are species which infest man, with the exception of *Planaria* and allied *Turbellaria*, Ehr., and of the orders *Acanthotheca*, *Syngamoidea*, and *Acanthocephala*, which have no representatives among the human internal parasites. For the parts of the body which these latter infest, the reader is referred to ENTOZOA.

) (Lat. intestinus, *internal*). The convoluted membranous and muscular tube extending from the pylorus to the anus. It is distinguished, in the human subject, into small and large intestines: the former including the *duodenum*, the *jejunum*, and the *ileum*; the latter the *cæcum*, *colon*, and *rectum*. The small intestines have internal membranous folds, called *valvulæ conniventes*; the large have three parallel muscular bands upon their surface. The intestines admit of separation into three coats: the external, membranous or peritonæal; the middle coat, muscular; and the inner one, villous. They are attached to the body by the mesentery. The structure of the intestinal canal in different animals is adapted to its required functions, dependent upon the nature of their food and other circumstances. Of these peculiarities the principal are adverted to under the titles of the animals in which they occur.

Intonation (Lat. in, and tonus, *a tone*). In Music, the act of sounding, with the voice or an instrument, the consecutive notes of the scale, or in any other given intervals. To do this correctly is the first qualification of a good singer. It is scarcely practicable without the assistance of a good ear, as well as a reference to some common idea, such as the key or mode wherein a piece is written. From the word *tone*, sometimes used in a sense almost identical with that of *key*, the word has its origin.

Intrados (Fr.). The lower line of an arch; the outer or upper line being known by the name of the *extrados*. [Arch.]

Intransitive (Lat. intransitivus, from in, neg., and transeo, *I pass over*). In Grammar, a word used to denote verbs expressive of actions of which the effects do not pass over to an object, as *I walk*, *I sleep*.

Intrenchment. In Fortification, a general term, denoting a ditch or trench with a parapet, for purposes of defence.

Intrinsic Equation (Lat. intrinsecus, *within*). The name proposed by Dr. Whewell in the *Cambridge Phil. Trans.* vol. viii for the equation which expresses the relation that exists between the length s of the arc of a curve, and the angle ϕ through which the tangent turns as its point of contact describes that arc. Thus if we suppose $f(\phi)$ to vanish with its argument ϕ, then the intrinsic equation of a curve will have the form $s=f(\phi)$. This granted,

$$\frac{ds}{d\phi}=f'(\phi)$$

will obviously be the expression for the radius of curvature, and the intrinsic equation of its evolute will be $s_1=f'(\phi)-f'(0)$. [Evolute.] The rectangular Cartesian equation of the curve is easily deduced from its intrinsic one. If both equations be referred to the same origin, and the initial tangent be taken as abscissa axis, we have

$$dx=ds\cos\phi=f'(\phi)\cos\phi\, d\phi$$

and

$$dy=f'(\phi)\sin\phi\, d\phi;$$

whence, by integration, we obtain two equations of the form

$$x=F(\phi, a) \text{ and } y=F(\phi, b),$$

from which by eliminating ϕ, the required equation, involving two arbitrary constants a and b, results.

The intrinsic equation of a curve may be advantageously employed in many enquiries, amongst which may be mentioned those relative to the successive involutes of a plane curve. [Involute.]

Introit (Lat. introitus, *entry*). In Ecclesiastical Antiquities, the verses chanted or repeated at the first entering of the congregation into the church; a custom as old as the fourth century: called *ingressa* in the Ambrosian Ritual. (Palmer, *Origines Liturgicæ*, ii. 19.)

Introrse (Lat. introrsum, *inwards*). In Botany, a term used in describing the direction of bodies to denote their being turned towards the axis to which they appertain; thus, in most plants the anthers are introrse, being turned towards the style.

Intrusion (Lat. intrudo, *I thrust upon*). In Law, a species of injury to freehold property. It arises when a stranger intrudes between the death of tenant for life or years and the entry of the heir of a remainder-man or reversioner expectant on the estate for life or years, who had died previous to the decease of such tenant for life or years. Writ of entry on intrusion was a special remedy for this injury, which having become obsolete was ultimately abolished by stat. 3 & 4 Wm. IV. c. 27.

Intuition (Lat. intueor, *I look into*). In Philosophy, any act of the mind by which a truth is *immediately* perceived, and as it were *beheld*, without any previous process of analysis or ratiocination. Such, according to Kant, are the fundamental propositions of geometry; as that 'two straight lines cannot inclose a space,' &c.

Intus-susception (Lat. intus, *within*, and susceptio, *a receiving*). In Anatomy, a term applied to the folding or passing of one portion of the intestinal canal into another.

Inula (Lat.). The Elecampane, long cultivated in herb-gardens, is the *I. Helenium* of botanists. It is a tall perennial herb, with large yellow composite flower-heads. Its root has an aromatic camphor-like taste, due to the presence of *helenin*, and contains also a quantity of starchy matter called *inulin*. Elecampane was at one time much used as an aromatic tonic and stimulant.

Inulin. An amylaceous substance contained in elecampane root. It differs from common starch in being rendered brown, instead of blue, by iodine.

Inundation (Lat. inundatio, from unda, *a wave*). In Agriculture, lands which are overflowed by water from natural causes uncontrolled by art, are said to be *inundated*: when in consequence of the exercise of art and skill, the result is termed *irrigation*.

Inundation. In Military Engineering, the

flooding a portion of country with a view to its defence, by rendering it impassable for an enemy. This is an important element in the defence of fortresses.

Invalids (Lat. invalidus, *weak*). Those soldiers or sailors who, either on account of wounds or length of service, are admitted into hospitals, and there maintained at the public expense. The practice of making provision for soldiers worn out or disabled in the public service dates from high antiquity, and the veterans of the Roman legions were often rewarded with grants of land. But such rewards emanated more from individual power or favour than from any general or established principles of benevolence. In modern times there is no civilised country without institutions for the maintenance of invalids; but the most magnificent are the Greenwich and Chelsea hospitals in England, and in France the Hôtel des Invalides.

Invariable Plane. [ROTATION.]

Invariant. Any function of the coefficients of a system of quantics is said to be an *invariant* of that system when it is equal, to a factor *près*, to the function derived in a similar manner from the linearly transformed system of quantics. [COVARIANT and CONCOMITANT.] The factor referred to is always a power of the modulus of transformation, and may be supposed equal to unity, in which case the transformation is said to be unimodular. [LINEAR TRANSFORMATION.] Thus the *resultant* of a system of equations is an invariant of that system, as may be seen à priori, inasmuch as the said resultant equated to zero expresses the condition that the equations should be satisfied by a certain set of values of the variables, and this property is obviously unaffected by linear transformation. Again, the *discriminant* of a quantic is necessarily an invariant, by the very nature of its formation. [DISCRIMINANT.] Of the many invariants of a quantic, a certain number are said to be *independent*; all others being expressible as rational integral functions of them. Thus, the binary quartic $(a_0, a_1, a_2, a_3, a_4 \between x, y)^4$, as Sylvester and Cayley have shown (*Phil. Mag.* April 1853, and *Phil. Trans.* 1856), has the two independent invariants

$$I = a_0a_4 - 4a_1a_3 + 3a_2^2,$$

$$J = a_0a_2a_4 + 2a_1a_2a_3 - a_0a_3^2 - a_4a_1^2 - a_2^3,$$

respectively called, for manifest reasons, the *quadrinvariant* and *cubinvariant* of the binary quartic. All other invariants of binary quartics can be expressed as rational functions of I and J; for instance, the discriminant, which is a *sextinvariant*, has the value $I^3 - 27J^2$. The sum of the suffixes of each term of either of the above invariants is visibly constant. This is a general property in virtue of which, and of certain differential equations which every invariant satisfies, any such function may easily be written down. The differential equations here referred to arise from the property which invariants, in common with covariants and the quantic itself, possess of giving the same results on applying the operations $y\frac{d}{dx}$, $x\frac{d}{dy}$, as they do under the application of the operations symbolised respectively by

$$\left[y\frac{d}{dx}\right] \quad \frac{d}{da_1} + 2a_1\frac{d}{da_2} + 3a_2\frac{d}{da_3} + \&c. \ldots$$

$$\left[x\frac{d}{dy}\right] = a_n\frac{d}{da_{n-1}} + 2a_{n-1}\frac{d}{da_{n-2}} + \&c.$$

[COVARIANT.] In the case of invariants the two former, and hence the two latter, results are manifestly zero. In his later researches, in fact, Prof. Cayley has defined an invariant as any function which is reduced to zero by each of the operations which, in the case of the original quantic, are tantamount to

$$y\frac{d}{dx},\ x\frac{d}{dy}\ \&c. \ldots$$

For further information on this very important subject, the researches of Cayley, Sylvester and others in the modern mathematical journals must be consulted; as an introduction to the subject, the *Lessons on the Higher Algebra* by Dr. Salmon will be found very useful. It may be here added that in geometrical applications, invariants equated to zero generally express the conditions under which a curve or surface will possess some permanent singularity, unaffected by the choice of axes, such as a double point, a conical point, and so forth. For instance, the discriminant

$$\begin{vmatrix} a, f, e \\ f, b, d \\ e, d, c \end{vmatrix}$$

of the ternary quadric $(a, b, c, d, e, f \between x, y, z)^2$, when equated to zero, expresses the condition that the conic represented by the latter breaks up into two right lines.

Invariantive Operation. An operation performed on a system of quantics, the result of which, after linear transformation of the variables which it may contain, is equal, to a factor *près*, to the result of the application of the same operation to the similarly transformed system. Thus it can be shown that the operations

$$\frac{d}{dx},\ \frac{d}{dy},\ \frac{d}{dz} \ldots$$

are contragredient to $x, y, z \ldots$ that is to say, if the latter are replaced by linear functions of themselves, the former must be replaced by the opposite or reciprocal linear functions of themselves; whence it follows that if

$$F(\xi, \eta, \zeta \ldots)$$

be any contravariant of a quantic,

$$F\left(\frac{d}{dx},\ \frac{d}{dy},\ \frac{d}{dz} \ldots\right)$$

will be an invariantive operation-symbol, and, according to the order of the contravariant, the result of operating upon the quantic with

the symbol under consideration will yield a covariant or an invariant. [COVARIANT; CONTRAVARIANT; INVARIANT.]

Invasion (Lat. invado, *I enter*). The hostile advance of an army into an enemy's country.

Invention (Lat. inventio, from invenio, *to find*). In the Fine Arts, the choice and production of such objects as are proper to enter into the composition of a work of art. 'Strictly speaking,' says Sir Joshua Reynolds, 'invention is little more than a new combination of those images which have been previously gathered and deposited in the memory: nothing can come of nothing: he who has laid up no materials can produce no combinations.'

Invention of the Cross. A festival celebrated, May 3, in the Roman Catholic church, in honour of the finding of what was said to be the true Cross. The search was instituted by order of Helena, mother of the emperor Constantine, A.D. 316; and the cross, according to St. Cyril, was found among the ruins of Mount Calvary.

Inventory. A catalogue of movable goods, as of furniture, or the like.

Inverse Functions. The results of the performance upon the same subjects of INVERSE OPERATIONS.

Inverse Method of Fluxions. The method of finding the *fluents* of given fluxional expressions. It is the same with the integral calculus.

Inverse Method of Tangents. The method of finding the curve whose tangents are lines drawn according to some given law. The tangents to a given curve can be found by the differential calculus, whereas to find the curve which has given tangents requires the aid of the integral calculus. The two methods, therefore, are *inverse* to one another. A simple example of a problem of this nature is to find the curve upon whose tangents two fixed right lines intercept equal segments; for instance, the curve to which a ladder reared against a vertical wall is always tangential. The determination of the caustic by reflection or refraction from a given curve is also effected by this method.

Inverse Operations. In Mathematics, two operations are said to be inverse one of the other, when their successive performance on any subject leaves the latter unchanged; in other words, when the one destroys the effect of the other. Addition and subtraction, multiplication and division, involution and evolution, integration and differentiation, are, severally, examples of inverse operations. If ϕ denote any operation whatever, the symbol for the inverse operation would be ϕ^{-1}, and the two would be so related that $\phi\,[\phi^{-1}(x)]=x$.

Inverse Proportion. In Arithmetic and Algebra, two quantities are said to be inversely proportional to two others with which they are respectively associated when the first is to the second as the associate of the second is to that of the first. Thus A and B are inversely proportional to a and b when

$$A:B=b:a \text{ or } A:B=\frac{1}{a}:\frac{1}{b};$$

that is to say, when the ratio of A to B is the reciprocal of that of a to b, or, otherwise expressed, is equal to the ratio of the reciprocals of a and b.

Inversion (Lat. inversio). In Geometry, a peculiar method of transformation. Two points, pp', are said to be inverse to each other, relative to a fixed point (*origin*) A, and a given *fundamental* quadric curve or surface (F), when they constitute a pair of conjugate points with respect to the latter, that is to say when the polar of one passes through the other, and when they are likewise collinear with A. Two curves, or surfaces, are said to be inverse to each other, when every point of the one has its inverse on the other.

Ordinarily, the fundamental curve (or surface) (F) is a circle (or sphere) whose centre coincides with the origin A. In this case the distances of inverse points from the origin are connected by the very simple relation $A\,p\,.\,A\,p'=k^2$, where k is the radius of the *circle* (or *sphere*) *of inversion* (F). Hence, metrical properties may be transformed by the simple formula

$$p'\,q'=\frac{p\,q}{A\,p\,.\,A\,q}k^2,$$

where p, p'; q, q' are any two pairs of inverse points. It may readily be shown that the inverse of a right line (or plane) is a circle (or sphere) through the origin, and vice versâ; and further, that the inverse of every circle (or sphere) which does not pass through the origin is itself a circle (or sphere). Moreover, if any two curves whatever intersect at a point p, their two inverse curves will intersect at the inverse point p' in such a manner that the angles formed at p and p' will be equal to one another.

A plane figure and its stereographic projection, as is well known, possess the property just mentioned. [PROJECTION.] They constitute, in fact, a pair of inverse figures. Hipparchus, therefore, may be said to have first employed inversion. As a geometrical *method*, however, inversion is of recent date. Steiner, in his *Geometrische Gestalter*, and Magnus in Crelle's *Journal*, vol. viii., studied in 1832 a method of transformation of which inversion is a particular case. Plücker, in 1834 (Crelle's *Journal*, vol. xi.), established its *descriptive* properties; and Bellavitis, in 1836, developed its *metrical* properties in the *Memoirs of the Lombardo-Venetian Academy*. In England the method was first published (as new) by Mr. Stubbs in the *Philosophical Magazine* for 1843. Prof. W. Thompson applied it in 1845, in his 'Theory of Electrical Images' (*Cambridge and Dublin Mathematical Journal*), and was followed by Liouville, who published an elaborate memoir on the subject in his *Journal des Mathématiques* for 1847. The method of inversion which has been universally employed for the last ten years may be appropriately

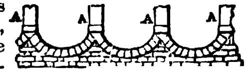
termed *cyclical* (or *spherical*), and the more general method above defined may be distinguished as *quadric* inversion. (*Proc. of Royal Society*, March 1865.) There are still more general methods of inversion in which the fundamental quadric is replaced by a curve (or surface) of any order whatever; but these have been little studied.

INVERSION. In Music, the interchange of place between two notes of an interval; that is, placing the lower note an octave higher, or the higher note an octave lower.

INVERSION. In Rhetoric and Philology, the transposition of words out of their natural order. Every language has a customary arrangement of its own to regulate the order of succession in which words forming part of the same sentence, member, or proposition follow each other. On the other hand, there is undoubtedly a natural or philosophical order of words following each other in the same analytical succession in which ideas present themselves to the mind, varied occasionally by that produced by the succession of sentiments or emotions; and as in every language many customary phrases, if not the general arrangement of the words, are contrary to this primitive order, every language has customary inversions of its own. Deviations from the customary order of words are more commonly called *transpositions*; but each word has, of course, a relative and somewhat arbitrary signification. As an instance of ordinary inversion, it may be observed that, according to the metaphysical or analytical order, the subject of a proposition precedes the predicate, being the first idea which presents itself to the mind. Thus, in the construction of a sentence containing a proposition [LOGIC], 'Solon is wise,' or 'Alexander reigns,' we habitually follow the order of nature. But when a substantive and adjective in connection form part of a sentence, i. e. a subject or predicate, or a part of either, the substantive is that which seems naturally to present itself first to the mind; whereas in most modern languages it follows the adjective, while in the Greek and Latin its ordinary although not its necessary place was before it: 'Who is a wise man?'—'Vir bonus est quis?' 'The end of a long silence.'—'Silentii diuturni finis.' It is in general to be observed, that modern languages admit of transposition far less readily than the ancient; but there are considerable differences in this respect between modern languages themselves. German admits much latitude, French very little. In our own language we are frequently able to vary the analytical order by following what may be termed the order of emotion, where a French writer could not do so. Thus in the proposition 'Great is Diana of the Ephesians,' it would be impossible, in French, to give the force which is added to the expression by the transposition of the predicate to the beginning without violating the habitual rules of construction. A similar instance of inversion is to be found in the Swedish and some kindred languages, in which the article follows instead of preceding the noun.

Invertebrata (Lat. in, priv., vertebra, *a joint* of the backbone). The animals which are devoid of vertebræ, or of an internal bony skeleton, and which include the Molluscous, Articulate, and Radiate subkingdoms of Animalia, in Cuvier's system. Lamarck's primary division of the animal kingdom into *Vertebrata* and *Invertebrata* corresponds with that proposed by Aristotle into *Enaima* and *Anaima.* It is, however, subject to the objection which applies to most of the Dichotomous systems in Zoology; namely, that the two members of the division are not equivalent to each other. The Invertebrata, for example, contain three if not four primary divisions of the animal kingdom, each of which is equivalent to the *Vertebrata.*

Inverted Arch. In Architecture, one wherein the lowest stone, or brick, is the keystone. It is used in foundations, to distribute the weight of particular points, such as A, A, A, over the whole of the foundations; and hence its employment is frequently of the greatest importance in constructive architecture.



Investiture (Lat. vestis, *a garment*). In Feudal Law, the delivery of a fief by a lord to his vassal, accompanied by peculiar ceremonies. [FEUDAL SYSTEM.] The investiture of a bishop was, properly speaking, his endowment with the fiefs and temporalties of the see. Hence it became a subject of contest between the popes and emperors, and one of the principal grounds of the great quarrel of Guelfs and Ghibellines. It was conceded by the emperors to the Roman see in 1122; but the question was ended by a substantial compromise, which left the nomination in reality in the hands of the temporal prince. (Hallam's *Middle Ages*; Raumer's *History of the Hohenstauffen*; Gieseler's *Text-book of Ecclesiastical History*; Mosheim's *Ecclesiastical History*.)

Investment of a Fortress. The enclosure of a fortress on every side with troops, all the avenues to it being occupied, so as to prevent the garrison receiving supplies, or communicating with other troops. This is the first step necessary in a siege.

Invocation (Lat. invocatio, from invoco, *I call upon*). In Literature, signifies, in a general sense, an address, at the commencement of a poem, to the Muses or some other Being supposed to be capable of giving inspiration. Among the most beautiful invocations must be reckoned that which precedes the long catalogue of chieftains in the second book of the *Iliad*. The extreme solemnity of this invocation, and the extraordinary richness of imagery with which it is introduced, are among the strongest arguments for the oral transmission of the Homeric poems during a long series of ages. (Gladstone, *Homer and the Homeric Age* i. 246.)

Invocation of Saints. In Theology. According to Protestant writers, the veneration of saints and martyrs increased rapidly throughout the fourth century; but their *invocation* as intercessors with the Divinity did not generally commence much before the fifth. The followers of Origen are said to have been the first 'who apostrophised the martyrs in their sermons, and besought their intercession.' Prayers *for* the saints among other departed spirits were discontinued about the fifth century, on the principle laid down by Saint Augustine, 'Injuria est pro martyre orare, cujus nos debemus orationibus commendari.' [MARTYRS; SAINTS.]

Invoice (connected by Mr. Wedgwood with Ital. avviso, Fr. avis, *a notice*). A list or account of goods or merchandise sent by merchants to their correspondents at home or abroad, in which the peculiar marks of each package, with their value, customs, provision, charges, and other particulars, are set forth. (*Commercial Dictionary.*)

Involucellum. In Botany, the secondary involucrum surrounding one of the umbellules of an umbelliferous flower, or the florets of a capitulum.

Involucrum (Lat. *a wrapper*). In Botany, a term applied to a ring or rings of bracts surrounding one or many flowers; also in describing ferns to denote the covering membrane which developes from beneath the sori; and in describing *Equisetaceæ*, to denote the cases of reproductive organs.

Involute (Lat. involutus, part. of involvo, *I roll upon* or *enwrap*). In Botany, when the edges of any organ are rolled inwards on each side, as occurs in the leaf of the apple.

INVOLUTE. In Geometry, the curve traced by any point of a flexible and inextensible string when the latter is unwrapped, under tension, from a given curve; in other words, the involute of a curve is the locus of a point in a right line which rolls, without sliding, over a given curve. This definition applies manifestly to the involutes of non-plane as well as of plane curves. The involute of every curve is an orthogonal trajectory of its several tangents, in fact a line of curvature on the developable osculatrix of that curve. An involute of a non-plane curve may be plane or non-plane; those of a plane curve, however, are all plane. The curve by unwrapping which a series of involutes is obtained, is said to be their common *evolute*, and any two involutes of a curve constitute a pair of *parallel curves*, their corresponding tangents being parallel, and their corresponding points, situated on the same normal, being equidistant.

The problem of finding the general equation of the involutes of a curv[illegible] a particular case of the problem of traject[illegible]s, and requires the aid of the integral calculus; it is discussed in all good text-books. This problem is considerably simplified when one involute is given; it becomes identical then with the problem of finding the parallel curves to the given involute.

The involute of an involute is called the second involute of the curve, the involute of this second is a third, and by proceeding in the same manner a whole series of involutes may be obtained. The properties of such a series have been little investigated. With respect to a series of plane evolutes, however, we are in possession of a remarkable theorem due in the first instance to John Bernoulli, but afterwards generalised by Euler (*Nov. Comm. Petrop.* 1764); according to this theorem the *ultimate involute of every curve is an epicycloid.* Demonstrations of this theorem have been given also by Poisson (*Jour. de l'École Polytechnique*, cah. 18), Legendre (*Exercices du Calcul Intégral*, t. ii.), Whewell (*Cambridge Phil. Trans.* vol. viii.), and Puiseux (Liouville, t. ix.). The theorem is also considered in Salmon's *Higher Plane Curves.* It should be observed, too, that the evolution of each involute is, in the above theorem, supposed to commence at the extremity corresponding to the termination of the preceding evolution. If the opposite method were pursued, and each evolution commenced at the extremity corresponding to the commencement of the preceding one, then the *rectilineal tail* of each involute being of the same length, the ultimate involute would be an arc of a logarithmic or equiangular spiral. (Dr. Whewell's *Memoir*; Boole's *Differential Equations*, p. 259.)

Involute of the Circle. The curve traced by the free extremity of a string as the latter is wrapped round a circle. The centre of the circle being the pole, and the radius (a) to the point where the wrapping ends being the polar axis, the equation of the involute in question is

$$\sqrt{r^2-a^2}=a\theta+a\cos^{-1}\frac{a}{r}.$$

The first positive pedal of the involute is the spiral of Archimedes; its reciprocal is the hyperbolic spiral, which is the inverse of that of Archimedes. [PEDAL.]

Involution. In Arithmetic, the successive multiplication of a number by itself. The result of $n-1$ such successive multiplications is called the n^{th} power of the number. The number n is called the *index* or exponent of the power, since it indicates of how many equal factors the product or power consists. The n^{th} power of a quantity a is denoted by the symbol a^n; thus $a^3=a.a.a$. It is evident, therefore, that $a^m.a^n=a^{m+n}$. This is the simplest expression of the *index law*, common to many operations besides that of involution. Evolution, or the extraction of roots, is the operation *inverse* to involution.

Involution of Points or of Rays. When two rows of points are so related that each point of the first determines a single point of the second, whilst each point of the latter determines n definite points of the former, the first series is said to form an involution of the n^{th} order. If o represent any origin in

the first line, and a any point of the involution, the latter may also be defined by an equation of the form

$$h \cdot \overline{oa}^n + h_1 \cdot \overline{oa}^{n-1} + \ldots h_n + \lambda \left(k \cdot \overline{oa}^n + k_1 \cdot \overline{oa}^{n-1} + \ldots + k_n\right) = 0,$$

where h, h_1 . . k, k_1 . . are constant coefficients, and λ a variable parameter, which individualises each group of n points. Thus, if $A = 0$ and $B = 0$ be the Cartesian equations of two curves of the n^{th} order, the pencil of curves represented by $A + \lambda B = 0$ will cut the abscissa axis, or any line in the plane, in a system of points forming an involution of the n^{th} order. Involutions of the second order have been hitherto almost exclusively studied; their properties are considered in Salmon's *Conic Sections*, in Mulcahy's *Principles of Modern Geometry*, and in Townsend's *Chapters on Modern Geometry*. The above generalised definition was given by De Jonquières, and probably suggested by the analogous definition of a quadratic involution first given by Chasles, *Comptes Rendus*, Dec. 24, 1855.

An involution of the first order is, of course, a simple series of points, and any involution whatever is manifestly determined by two groups. In general there are $2(n-1)$ of these groups which contain two coincident points; these are the *double points* or *foci* of the involution. They are found, of course, by equating to zero the discriminant of the preceding equation, which discriminant is well known to be of the $2(n-1)^{th}$ degree in λ. [DISCRIMINANT.] The group which includes the point at infinity amongst its constituents is called the *central* group, each of its points is characterised by the property that the product of its distances from the n points of any other group is invariable. Thus, in an involution of the second order, if o denote the point whose conjugate is at infinity, and a_1 a_2 the two points which constitute any other group, $0a_1 \cdot 0a_2 = \text{const.}$ From this it follows at once that an involution of the second order results from two homographic rows of points so superposed that the point of each row which corresponds to infinity on the other coincides with one and the same *central point* o. [HOMOGRAPHIC.] It is obvious, too, that in an involution of the second order the anharmonic ratio of any four points is equal to that of their four conjugates. If in any involution whatever, the harmonic centre be taken, with respect to any pole, of the points of each group, a row of points will be obtained which will be homographic with any similar row of centres taken with respect to a different pole. The anharmonic ratio, therefore, of the harmonic centres, of the first order, of any four groups is invariable, no matter what pole may be chosen. This ratio is called the *anharmonic ratio of the four groups*, and if these groups correspond to the values λ_1 λ_2 λ_3 λ_4 of the parameter λ, the ratio is expressed by

$$\frac{\lambda_1 - \lambda_2}{\lambda_2 - \lambda_3} : \frac{\lambda_1 - \lambda_4}{\lambda_3 - \lambda_4}.$$

Two involutions of the orders m and n, respectively, are said to be homographic when the harmonic centres, with respect to any pole, of the groups of the one, and the harmonic centres, with respect to the same or any other pole, of the groups of the other, form two homographic rows of points. It follows, then, from the above definitions that the groups of two homographic involutions *correspond anharmonically*; that is to say, the anharmonic ratio of any four groups of the one is equal to that of the corresponding groups of the other. When two homographic involutions of the orders m and n are superposed, there are in general $m + n$ *common points*, that is to say points with each of which coincide constituents of corresponding groups. Two superposed involutions of the same order, higher than the second, have not in general a common group; they can never, of course, have two common groups. Two superposed quadratic involutions, however, have in general a common group.

The rays of a plane pencil are also said to form an involution of the n^{th} order when they intersect any transversal in an involution of points of that order.

Io (Gr. Ἰώ). In Greek Mythology, this mythical being is the subject of a very large variety of legends. According to one of the most popular versions, she was a daughter of Inachus, king of Argos. The love of Zeus for this maiden roused, as in other myths, the jealousy of Hera, who transformed Io into a heifer, and placed her in the charge of Argos Panoptes. This guardian was slain by Hermes, who was thence called Argeiphontes, or the Slayer of Argus. Hera then sent a gadfly, which stung the heifer and drove her in madness over the earth. Thus began those wanderings of Io which Æschylus has sketched in his drama of *Prometheus Chained*. The tale of Io is thus connected with the legend of Epaphus, the calf-god (identified by Herodotus with the Egyptian Apis), and also with the myths of Heracles, of whom, according to the prophecy of Prometheus, she was to be an ancestor.

Iodates. Salts of the iodic acid.

Iodine (Gr. ἰώδης, *violet-coloured*). A substance discovered in 1812 by M. Courtois of Paris. In this country it is usually prepared from kelp, which is lixiviated with water; and, when the crystallisable salts have been separated, the mother liquors are mixed with sulphuric acid and black oxide of manganese. On the application of heat the iodine rises in the form of a dense violet-coloured vapour, which by condensation forms steel-grey crystals looking like micaceous iron. The specific gravity of iodine is between 4 and 5; when dry it fuses at 227°, and boils and evaporates in purple fumes at 345°. When heated with water it distils over at temperatures below 212°. The specific gravity of its vapour is about 8·7, so that 100 cubic inches would weigh nearly 270 grains. Iodine belongs to the electro-negative supporters of combustion. It has an acrid taste, and a peculiar odour somewhat like

that of chlorine. It is an irritant poison; but in small doses, and cautiously administered, it has occasionally been of great service in certain forms of glandular disease. It is very sparingly soluble in water, of which it requires 7,000 parts for its solution; the colour of the solution is brown: it dissolves copiously in alcohol and in ether, and forms dark-brown liquids. It possesses strong powers of combination, forming, with the metals, a class of compounds called *iodides*; with oxygen it forms the *iodic acid*, and perhaps one or more oxides. Combined with hydrogen, it forms the *hydriodic acid*. Its equivalent number is 126, and that of the hydriodic acid 127. Starch is a characteristic test of the presence of free iodine, forming with it a compound of a deep blue colour. It is so delicate that a solution of starch dropped into water containing less than a 400,000th part of iodine, is tinged blue by it; but the solutions must be cold, for the blue compound disappears in hot water. The great consumption of iodine is in medicine; it is chiefly employed in the form of *iodide of potassium*, which is obtained by dissolving iodine in a solution of pure potash, evaporating to dryness, and fusing the residue.

Iodite. Native iodide of silver. It occurs in hexagonal crystals, and in thin plates of a greyish or silver-white colour, at Guadalajara in Spain, Albarradon in Mexico, and at the Delirio mines of Chañarcillo in Chili.

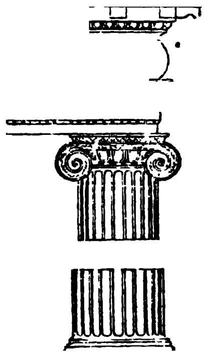
Iodoform. A substance in the form of yellow scales, produced when alcohol, iodine, and potash are brought together.

Iodoquinine. An organic substance formed on rubbing quinine with iodine. The bisulphate of iodoquinine may be obtained in large lamellar crystals, which perfectly polarise light.

Iolite (Gr. *ion*, *violet*). A mineral of a violet-blue colour by transmitted light; it occurs crystallised, and in small grains and rolled masses.

Ionic Dialect. This most euphonious of the four written varieties of the Greek language, was spoken by the inhabitants of the Ionian Islands, and in their colonial possessions in Asia Minor. The chief writers in the Ionic dialect are Herodotus, Hippocrates, and Galen; but it is in the writings of the first that the most complete specimen is to be found.

Ionic Order. One of the five orders of Architecture, of which the distinguishing feature is the volute of its capital. In the Grecian Ionic, the volutes appear the same in the front and the rear, being connected in the flanks with a kind of baluster-like form; though in the external angles of the inner columns a diagonal volute is introduced. The Romans made their Ionic capital with four diagonal volutes, and they curved the sides of their abacus. The Greek volute continues the fillet of the spiral along the face of the abacus; whereas in the Roman order its origin is behind the ovolo. In some Grecian examples, a neck is added below the echinus, sculptured with flowers and leaves. The height of the column is about nine diameters, and the base varies greatly in different examples. When a pedestal is used, it is somewhat higher, and more ornamented, than the Doric pedestal. The Greeks usually made the entablature of this order very simple; the architrave has two fasciæ, the frieze is plain, and the cornice of few subdivisions; but the modern Ionic has seldom less than three fasciæ in the architrave; the frieze is often cushioned, and the cornice is deeper and not unfrequently modillioned, its profile being much varied. The dentil is also much used in the bed mouldings. The shaft is cut into twenty-four flutes, separated by fillets. Some of the most celebrated examples of the order are the temple on the Ilyssus, of Athena Polias at Athens, of Bacchus at Teos, and of Fortuna Virilis at Rome. The profile above given is after Palladio.



Ionic Philosophers. The earliest among the Greek schools of philosophy. Speculation arose in Greece, as elsewhere, in the attempt to discover the laws of outward phenomena, and the origin and successive stages of the world's developement. Such an attempt, it is needless to say, must at first have been extremely rude. But to the student of philosophical literature no such undertaking, however unsuccessful, can possibly be otherwise than interesting; and in this instance in particular we are able to discover manifest traces of that liveliness of thought and systematic spirit which distinguish the later Greek speculations. The fathers of the Ionic school were Thales and his disciple Anaximenes. They were succeeded in the same line of thought by Diogenes of Apollonia and Heraclitus of Ephesus. The characteristical mark which distinguishes the speculations of these thinkers is the endeavour to refer all sensible things to one original principle in nature. The two first named were satisfied with a very simple solution of the problem. Water with the one, and air with the other, were made the original materials out of which all things arose, and into which they were finally resolved. In their successors the germs of a more philosophical doctrine are apparent. They retain, indeed, the simplicity of an original element; but the *air* of Diogenes and the *fire* of Heraclitus are apparently only sensible symbols, which they used only in order to present more viridly to the imagination the energy of the one vital principle which is the ground of all outward appearances. It

would indeed be a mistake to regard these philosophers as *materialists*. The distinction between objective and subjective, between a *law* operating in the universe and the corresponding apprehension of that law by reason, however obvious it may seem at the present day, seems to have required the deep meditation of numerous powerful thinkers to bring it into clear consciousness.

That the two things were confounded by Heraclitus is evident from his attributing to this universal fire the attributes of a universal reason —the source at once of the order in the world, and of the insight into that order possessed by man. Notwithstanding this confusion, the discovery is due to him of the important truth, that 'reason is common to all men'—that the ultimate principles of science derive their validity from their universality; a truth the value of which is not diminished by our finding it combined with the physical hypothesis of which we have spoken.

The philosophers enumerated above may be considered as forming one division of the Ionic school. They agree in regarding the universe as the result of the spontaneous evolution of a single principle or power; and all sensible things as modifications of this principle, real only in reference to their ultimate ground. But we meet also with a class of thinkers in whom the contrary tendency prevailed. Anaximander, a contemporary of Polycrates, and Anaxagoras, the master of Pericles, agree in this respect, that they consider the world to be made up of various small particles, of different kinds and of various shapes, by the change in whose relative position all phenomena are to be accounted for. This hypothesis is combined by Anaxagoras with a Supreme Reason, the author of all that is regular and harmonious in the disposition of these elementary atoms. Anaxagoras may indeed be considered as the first philosopher who clearly and broadly stated the leading distinctions between mind and matter. For a statement at once luminous and accurate of the leading peculiarities of this philosopher's doctrines, and those of his predecessors, see Thirlwall's *History of Greece*, vol. ii. chap. xii. The student who wishes for more minute information may consult Brandis and Ritter's *Histories of Philosophy*; the 'Fragments of Heraclitus' in Wolf and Buttmann's *Museum of Antiquities*; and the *Mémoires de l'Académie des Inscriptions*, vol. xvii.

Ionidium (Gr. ἴον, *a violet*, and εἶδος, *likeness*). A genus of South American *Violaceæ*, some of whose species contain emetin, and may therefore be used as Ipecacuanha. The roots of *I. Ipecacuanha* form White Ipecacuanha, while those of *I. microphyllum*, which act powerfully as emetics and purgatives, are famed in Peru for the cure of tubercular elephantiasis. Other species also possess medicinal properties.

Ipecacuanha (Peruv. ipe, *root*, and cacuan, a native distinction for this root). The root of the *Cephaëlis Ipecacuanha*. This important article of the *Materia Medica* is the produce of South America; it is found in short wrinkled pieces, covered with a grey or brownish grey epidermis, and having a central woody fibre, surrounded by a pale grey cortical part, in which its virtue resides. It has a nauseous odour, and a repulsive, bitterish taste. It is not easily reducible to powder; and the dust which it throws off, whilst under the process of pulverisation, is apt to excite great irritation of the respiratory organs. From fifteen to twenty grains of powdered ipecacuanha root taken in an ounce of water, is one of the safest and surest *emetics*; in doses of from one to three or four grains, it is a *nauseant*; and in smaller doses, repeated every four or six hours, as from a fourth of a grain to a grain, it is expectorant and diaphoretic. It contains from twelve to sixteen per cent. of *emetin*, to which its medical activity is referable. When long boiled with water, its emetic power is diminished, but the decoction is aperient. There are several varieties of ipecacuanha, some of which arise from modifications of soil and climate; others appear to be the roots of distinct plants. Among the latter are the roots of *Psychotria emetica, Ionidium Ipecacuanha, Boerhaavia decumbens*, and *Richardsonia scabra*.

Iphigeneia. [Theseus.]

Ipomœa (Gr. ἴψ, *a worm*, and ὅμοιος, *like*). A large genus of the order *Convolvulaceæ*, comprising many species of great beauty, and some of much utility. Several of them yield Jalap, or analogous substances, though the best Jalap comes from *Exogonium*: among these *I. Turpethum, pandurata*, and *batatoides* may be particularly mentioned.

Iriartea (after Iriarte, a celebrated Spanish botanist). This genus of South American palms well illustrates a curious habit in certain plants of the palm family, that of elevating their trunks, as it were, entirely above ground, on a conical mass of cylindrical roots. In *I. exorrhiza*, the Paxiuba palm of Brazil, the cone of roots is sometimes so high that a man can stand in the centre, with the tall tree above his head. The exposed roots are covered with little asperities, and are hence used by the Indians as graters, while the hard outer wood is used for their houses, and also for making umbrella handles.

Iriartella (after Iriarte). The South American palm formerly named *Iriartea setigera*, which grows twenty feet high, with a perfectly straight cylindrical trunk, scarcely more than an inch thick. From this trunk the Indians form their blow-pipes, through which they blow small poisoned arrows to a considerable distance.

Iridaceæ (Iris, one of the genera). A natural order of herbaceous Endogens, inhabiting the Cape, and some other places. It differs from *Amaryllidaceæ*, essentially, in being triandrous, with the anthers turned outwards; from *Orchidaceæ*, in not being gynandrous; and from *Zingiberaceæ* and *Marantaceæ*, in having three perfect stamens. The species are more remark-

able for their beautiful flowers than for their utility. The substance called saffron is the dried stigmata of the *Crocus sativus*. The various species of *Iris*, *Ixia*, *Gladiolus*, *Tigridia*, *Crocus*, &c. are among the favourite flowers of the gardener.

Iridæa (Gr. ἶρις, *the rainbow*). One of the edible Seaweeds, belonging to the rose-spored division. *I. edulis*, which is sometimes eaten like common dulse, is known by its tough obovate dark red frond, which is wedge-shaped at the base. It has been used as dye, but its colour appears to be fugitive.

Iridescent Films. Iridescent films are produced by dropping a little oil or spirit varnish upon the surface of water contained in a vessel. When the water becomes tranquil, the varnish spreads in all directions, becoming exceedingly attenuated, and reflects the most vivid colours of the spectrum. If any objects that require ornamenting, such as insects, shells, birds, bronzes, paper-hangings, &c., are previously immersed in the water, and slowly raised to the surface, after the film has been formed, the latter will adhere to their surfaces, and when they are completely dried it will be found firmly attached to them, and perfectly iridescent, having lost nothing of its brilliancy of colouring. This is a beautiful illustration of the production of colours on a thin transparent and colourless surface, by the agency of light, such as is seen in an ordinary soap bubble. [INTERFERENCE.]

Iridiocyanogen. The supposed negative radicle of a double salt of cyanide of iridium and of potassium.

Iridium (Gr. ἶρις, *the rainbow*, in consequence of the variety of colours exhibited by its solutions). A metal discovered by Dr. Wollaston, associated with the ore of platinum. It is grey, brittle, very difficult of fusion, and its specific gravity is about 18·6. It forms several oxides and chlorides, and combines readily with carbon.

Iridosmine or **Irid-osmium.** Native osmide of iridium, in which the iridium is more or less replaced by platinum, rhodium, and ruthenium. It generally occurs in small irregular flattened grains, harder, heavier, and of a rather paler steel-grey colour than native Platinum, with which it is found, in the province of Choco in South America; in the Ural Mountains of Siberia; in the alluvial gold of California; Australia, Borneo, &c. Iridosmine is also known by the name of Native Alloy.

Iris (Lat.; Gr. ἶρις). In Anatomy, the anterior part of the choroid coat of the eye, with superadded muscular fibres. Its central perforation is called the *pupil*; the posterior part or back of the iris is called the *uvea*. The term *iris* is applied to that part of the eye on account of its various colours. [EYE.]

IRIS. In Astronomy, one of the newly discovered planets of the group between Mars and Jupiter.

Iris. In Botany, the name of a very beautiful genus of plants, typical of the IRIDACEÆ [which see].

IRIS. In the Homeric Mythology, Iris is the messenger of the gods who carries messages from Ida to Olympus, or from the gods to men. In the Hesiodic *Theogony*, she is a daughter of Thaumas and Electra, and a sister of the HARPIES. According to later versions, she was married to Zephyrus, and became the mother of EROS. This legend gives, perhaps, some ground for connecting the names *Iris* and *Eros*, together, with the Vedic Arusha. In the *Iliad* the rainbow also was called Iris; but the personification of Iris as the goddess of the rainbow seems to be of later growth.

IRIS. The name given by French jewellers to limpid and transparent stones, but chiefly to Rock Crystal when reflecting prismatic colours like Opal, by means of natural internal flaws. Common Rock Crystal is sometimes artificially converted into iris, but in these cases the fissures are produced in the outer part of the stone instead of being in the interior. Imitation iris has lately made its appearance in the London shops, made into sleeve-buttons, solitaires, &c. under the name of Pierre des Alpes, &c.

Iriscope (Gr. ἶρις, and σκοπέω, *I view*). An instrument proposed by Dr. Joseph Reade for exhibiting the prismatic colours, thus described by Sir David Brewster, in the *Phil. Trans.* for 1841: 'This instrument consists mainly of a plate of highly polished black glass, having its surface smeared with a solution of fine soap, and subsequently dried by rubbing it clean with a piece of chamois leather. If we breathe upon the glass surface, thus prepared, through a glass tube, the vapour is deposited in brilliant coloured rings, the outermost of which is black, while the innermost has various colours, or no colour at all, in proportion to the quantity of vapour deposited. The colours in these rings, when seen by common light, correspond with Newton's *reflected* rings, or those which have *black centres*, the only difference being, that in the plate of vapour, which is thickest in the middle, the rings in the iriscope have black circumferences.'

Irish Moss. The *Chondrus crispus*. [CARRAGEEN MOSS.]

Irite. A mineral found in octahedrons and in lustrous black scales, which are attracted by the magnet, filling up interstices in the platinum of the Ural.

According to Hermann, it is a compound of the peroxides of iron and chromium with the protoxides of osmium and iridium; but Claus considers it to be merely a mechanical mixture of several substances, chiefly iridosmine and chromic iron.

Iritis. Inflammation of the iris of the eye.

Iron (Sanscr. ayas, probably at first *the metal*, i.e. *copper*, although in Sanscrit the word is confined almost exclusively to iron; Lat. aes, *brass*; Old High Ger. êr, *bronze*; Goth. eisarn, *iron*, changed in Old High Ger. to isarn and

îsan = Mod. Ger. eisen, while the A.-Sax. *isern* leads to *iren* and *iron*: Max Müller, *Lectures on Language*, second series, p. 233). This important metal is largely diffused in the state of oxides and carbonates; it is also found combined with sulphur, and with several acids, and is a common component of many minerals. It occurs in small quantity in some animal and vegetable bodies, and mineral waters, and it forms the principal component of many meteoric stones. Its chemical symbol is Fe, and its equivalent or atomic weight is 28.

Manufacture of Iron.—The argillaceous iron ore of the coal-measures is the principal source of British iron. It occurs in nodules and seams, alternating with coal, shale, and limestone, and contains from 70 to 80 per cent. of carbonate of iron, the remainder being chiefly clay and carbonate of lime. It is first roasted, either in kilns or heaps, and, mixed with coke and limestone, is subjected to the intense heat of the blast-furnace; these materials being successively thrown in from above, and gradually descending till they reach the lower or hottest part. In their descent the iron is reduced, and in combination with a portion of carbon falls through the fused slags to the bottom of the furnace, whence it is withdrawn at intervals, by opening the *tap-hole*, while the slags are allowed to run off by an aperture left for the purpose: they consist chiefly of the silicates of lime and alumina, with smaller proportions of the silicates of magnesia, manganese, and iron.

The smelting furnaces are usually about 50 feet high, and 15 feet in the widest part of their internal diameter; they are constructed of strong masonry and brickwork, and lined with the most refractory fire-stone. They are worked day and night for several successive years, air being supplied to them by powerful blowing machines, generally so constructed as to throw it in in a heated state, or as a *hot blast*, and to the amount of about six tons weight per hour. It is estimated that by the use of hot instead of cold air, a very large saving of fuel is effected. With the cold blast, about eight tons of coal are consumed in the production of a ton of iron; whereas with the hot blast, less than three tons are sufficient, and with it coal may be substituted for coke. These furnaces are usually tapped night and morning, furnishing from eight to ten tons of metal daily, and requiring an hourly supply of about a ton and a half of the mixture of roasted ore, limestone, and coal or coke. The melted metal is suffered to run into rough moulds of sand, and in this state constitutes the *cast* or *pig iron* of commerce.

There are several varieties of cast iron, but they are commercially distinguished as 1. *grey*, 2. *mottled*, and 3. *white*. They are all *carbides*, and the grey and mottled varieties include a portion of graphite diffused through them, which remains undissolved and unchanged after the action of dilute sulphuric acid, whilst the greater part of the combined carbon unites to the hydrogen, forming hydrocarbons. Cast iron also contains silicon, phosphorus, manganese, and traces of calcium, aluminum, and sulphur.

Grey cast iron is soft and somewhat tough; it admits of being bored, and turned in the lathe. When immersed in dilute hydrochloric acid it leaves a black insoluble residue; its texture resembles bundles of small needles. *Mottled iron* is coarser grained, and small particles of graphitic carbon may be discerned in its fracture. *White cast iron* is very hard and brittle; acids act but slowly upon it, and develope a lamellar rather than a radiated texture: it sometimes contains as much as five per cent. of carbon, so that it is nearly represented by Fe_4C, and may be regarded as iron saturated with carbon.

When small articles of cast iron are bedded in oxide of iron (powdered hæmatite is generally used), and kept for some hours at a red heat, they are to a great extent *decarbonised*, and so far softened as to resemble wrought iron, especially when they are slowly cooled. In this operation the carbon of the cast iron appears to be gradually removed, in the form of carbonic oxide, at the expense of a part of the oxygen of the oxide in which they are embedded.

Wrought or malleable iron is the metal in a comparatively pure state, though it retains traces of carbon, and of some of the other impurities of cast iron. To effect the conversion of cast into wrought iron, the cast metal is in the first instance *refined*, by subjecting it to the action of air at a very high temperature, in a kind of forge furnace. Much of the carbon is thus burnt off; and the silicon, converted into silica, forms a fusible slag with the oxide of iron, which tends to the further purification of the mass. The fused metal is then run off, and formed into cakes, which are rapidly cooled by the affusion of water. The silicate of iron formed in this process is partly derived from the rough cast iron, and partly from added sand; it approaches the composition $3(FeO)SiO_3$, and itself performs a part in cleansing the metal, by acting as an oxidising agent. The further and final purification of the metal is effected by a process called *puddling*, carried on in a reverberatory furnace, which admits of the fusion of the refined iron by a current of intensely heated air and flame, without direct contact with the fuel. Here the metal is well stirred, so that the superficial oxide may be mixed in the mass, which soon begins to heave and emit jets of carbonic oxide, and gradually growing tough and less fusible, becomes at length pulverulent. The fire is then urged so that the particles again agglutinate at a welding heat, and admit of being made up into globular masses, or *blooms*, and in that state of intense heat are subjected to the *shingling press*, or to *rollers*, by which extraneous matters are squeezed out in the form of slag, and the density of the metal

increased; it now admits of being rolled into bars, which are cut into convenient lengths, placed in parcels in a very hot reverberatory furnace, and again rolled. The metal is now tough, flexible, and malleable, but less fusible, and is, in fact, nearly pure, retaining not more than $\frac{1}{200}$ part of carbon, and traces only of other matters.

The slags formed in the operations of refining and puddling, containing about sixty per cent. of iron, are reduced in the blast furnace, in the same way as the original ore, but the iron so produced is *cold short*; it admits of working at a red heat, but is brittle when cold, a quality supposed to depend upon the presence of phosphide of iron, derived from phosphate of iron existing in the slag. Iron is also occasionally *red short*, that is, brittle at a red heat, though malleable when cold: this quality has been ascribed to traces of arsenic and copper.

Many other processes for the conversion of cast into wrought iron have been suggested, and amongst them that of Mr. Bessemer deserves especial mention; it consists in passing currents of air and steam through the fused metal. For details upon these subjects the reader is referred to Percy's *Metallurgy*; to Ure's *Dictionary of Arts and Manufactures*; and to the article 'Iron' in Watt's *Dictionary of Chemistry*.

At what period iron began to be made in this country, there is no means of ascertaining; but there is authentic evidence to show that iron works were established by the Romans in the Forest of Dean and in other parts of the kingdom.' (Pennant's *Wales*, vol. i. page 80, ed. 1810.) They were also established at a very early period in Kent and Sussex; but it was not until after the celebrated invention of Lord Dudley in 1619, by which pit coal was substituted for wood in the smelting of iron ore, that a great impetus was given to the working of this valuable mineral; an invention which, though interrupted and clogged for a time by the devices of an ignorant rabble, at last established for itself a sure footing both in this and in every other country in the civilised world. From 1740 (the date when Lord Dudley's invention became generally adopted), the progress of the manufacture, in England, has exceeded the most sanguine expectations; and though we have no means of ascertaining the exact quantity produced, the subjoined estimates will show at one glance the importance of the manufacture, and the unexampled rapidity of the growth of this branch of the national production during the last and the present centuries. In 1740 the quantity of iron manufactured in England and Wales was only 17,000 tons; in 1750, it was 22,000 tons; in 1788, it was 68,000 tons; in 1796, it was 125,000 tons; in 1806, it was 250,000 tons; in 1820, it was 400,000 tons; in 1827, it was 690,000 tons; in 1840, it was 1,000,000 tons; in 1850, it was nearly 2,000,000 tons, and in 1857 it was estimated that the total production of England was about 3,000,000 tons of crude iron. The other nations have made great advances in appropriating the most economical processes of the conversion of iron; but they have not hitherto more than equalled the production of England.

Properties.—Iron is fusible at a white heat, but with great difficulty when perfectly pure. It requires the highest heat of a wind furnace to run down soft iron nails into a button, and therefore a temperature equal to about 3,300°. Its sp. gr. is 7·8. Its texture varies with the method of working: in bars or wires it appears longitudinally fibrous, but when long kept at a red heat it acquires a crystalline texture, and a tendency to cuboidal fracture. It is the hardest and toughest of the ductile metals; it may be drawn into fine wire, but cannot be hammered out into thin leaves; it is very tenacious; and at a bright-red or orange heat it admits of being *welded*, or joined by hammering, to another piece of the red-hot metal. It is attracted by the magnet, but does not retain magnetism when pure; at a bright-red heat it becomes indifferent to it, but reacquires this property on cooling.

To obtain pure iron, filings of the best bar-iron may be mixed with about one-fifth their weight of pure peroxide of iron, and exposed (covered with pounded glass quite free from lead) in a well-closed crucible, for about an hour, to the strongest heat of a forge. Exposed to heat and air, iron becomes superficially converted into a fusible oxide; when exposed to a damp atmosphere, it becomes incrusted by a brown *rust*. When in a state of extreme division, its affinity for oxygen is such, that it heats, and even ignites, on exposure to air; this is the case with the metal as obtained by the action of hydrogen upon red-hot oxide of iron, and when thus reduced, at a temperature not sufficient to cause the adhesion of the particles of the metal, and suffered to cool in an atmosphere of hydrogen, it requires the same precautions for its preservation as potassium. A spontaneously combustible form of iron is also obtained by the ignition of Prussian blue. In a dense mass, iron is not affected by dry air, and it even retains its polish when immersed in pure water which has been deprived of air; but in common water, or in water exposed to air, it soon rusts. This oxidisement by water is prevented by the alkalies; and in lime water, or in a weak solution of ammonia, potash, or soda, the metal keeps its lustre.

Iron is susceptible of four definite degrees of oxidisement– forming a *protoxide* (FeO), which has not been isolated, but which is the basis of a series of well-defined salts; a *sesquioxide* (Fe_2O_3), generally termed *red oxide* or *peroxide*; a *black* intermediate oxide, known also under the name of *magnetic oxide* (Fe_3O_4), and a *hyperoxide*, called *ferric acid* (FeO_3), but which, like the protoxide, has not been isolated.

The oxides of iron are the common colouring matters of the mineral kingdom; the peroxide is much used as a pigment, and in the

state of *hydrate* for the purification of coal gas by the abstraction and decomposition of sulphuretted hydrogen. The compounds of iron with chlorine, &c., generally correspond in atomic composition with the protoxide and peroxide. The sulphides are represented by FeS and FeS_2: there is also a sesquisulphide $=Fe_2S_3$. [PYRITES.]

Many of the salts of iron are of much importance in the arts, more especially as mordants in dyeing and calico printing, in the manufacture of common writing ink, of Prussian blue, and of several pharmaceutical preparations: the principal of these will be found noticed under other heads. The presence of iron in water is recognised by its inky taste, by the deposition of a yellow or brown precipitate when boiled or exposed to air; by a purple or black tinge with infusion of galls, and a blue tinge with ferrocyanide of potassium. The salts of the protoxide are mostly converted into those of the peroxide, by exposure to air, or by common oxidising agents.

Iron Armour Plates. Plates used for the protection of vessels of war, and fortifications, against modern artillery. Although iron armour was suggested in America in 1812, and in France in 1821, the first English experiment recorded took place at Woolwich in 1827, at the instigation of General Ford, who proposed to protect masonry with wrought-iron bars. The result of this experiment being unsatisfactory, the idea was abandoned; and though revived again in this country in 1850, it was first brought to a practical issue in France. The French floating battery, engaged at Kinburn in 1855, was so superior to its wooden companions, that the question of iron defences was taken up by our Admiralty. A committee assembled, and carried on experiments until 1860, which ended generally in this result: That a good wrought-iron plate, 4½ inches thick, backed with 18 inches of teak, was practically proof against the 68-pounder and 7-inch breech-loader Armstrong gun, at a range of 400 yards. On the data thus obtained, the Warrior, Black Prince, Defence, and Resistance, were built, their construction being as follows: 4½-inch wrought-iron plates, each 15 feet by 3 feet 2 inches, fastened by 1¼-inch bolts, riveted on the inside; then a backing of 18 inches of teak well caulked, and a ⅝-inch wrought-iron skin on iron ribs, 18 inches apart. The bow and stern of the Warrior and Black Prince are covered with only ⅝-inch boiler plate, in order to lessen the weight.

A new committee was appointed early in 1861, which continued its labours until early in 1864, during which period very heavy guns were made, and brought to bear upon armour-plated targets of various constructions. The following are the chief results established by this course of experiments.

1. Wrought iron of the softest quality is best adapted for armour plate; and the least approach to steely quality of iron should be avoided. 2. Very powerful machinery is absolutely necessary, and rolled plates are better than hammered. 3. Large and wide plates are better than small and narrow, all plates being weakest near the edges. 4. Tongueing and grooving weakens the plate, and tends to destroy the plate adjacent to that which is struck. 5. A combination of bars is inferior to a solid plate of the same weight or thickness. 6. A series of thin plates is similarly inferior. 7. Generally, no combination is so good as a solid plate, the resistance of which, up to a certain point, may be assumed to be nearly as the square of the thickness. 8. No advantage is gained by placing plates at an angle if the iron must be made thinner in consequence; or, in other words, iron of a given weight is most usefully employed in thick vertical plates. 9. Rigid backing is best for fortifications, but a soft backing yields to any distortion of the plate, distributes the effect over a larger area, and diminishes the damage to the general structure. 10. Wooden backing answers these conditions as well as, or better than, any other. 11. Increase of thickness of plate does not compensate for considerable diminution of backing. 12. All irregularities of surface, such as bosses, &c., tend to weaken the plate. 13. A facing of wood, or other material, saves the plate to some extent; but is easily destroyed by shell. 14. The bolts which fasten the plates should be of large diameter, at least two inches; countersunk bolts, with conical heads and double nuts, have been found to answer best. 15. Soft washers should be used to protect the fastenings.

The above results, as may be observed, confirm the fact established by experiment, that the Warrior target, in proportion to its weight, offers the best protection of any target yet tried. Steel projectiles, both shot and shell, from large guns, have passed through this target; and there is no doubt that after we have arrived at the maximum thickness of iron which a vessel can be made to carry, there will be little difficulty in constructing a gun to send a projectile through its sides. A shell of 585 lb. weight, containing 24 lb. of powder, fired from the 13-inch Armstrong gun, recently penetrated the Warrior target, though the charge had been reduced so as to give the shell a velocity on striking equal to what it would have been at 2,000 yards with the ordinary service charge.

War vessels have been built, under the direction of the chief constructor of the navy, having a greater thickness of armour than that of the Warrior; such are the Minotaur and Bellerophon; and the cupolas of the Royal Sovereign, a man-of-war altered on Captain Coles' plan, have a thickness of plating, around the ports, of eleven inches.

Iron-clads have been extemporised in America during the late war, by both the Northern and Southern States, by fastening rails or chain cables along the sides of the vessels. This kind of armour, although sufficient to break up cast-iron shells, as shown in the action between the Kearsage and Alabama, off Cherbourg,

would offer little resistance to the steel projectiles now in use with the artillery which will be brought against iron-clad vessels.

Some alterations are likely to be made in the manner of securing the plates, the bolt system being very defective. Wood screws appear to give good results, and may possibly be substituted for, or used in conjunction with, bolts.

The weight of armour which a ship can carry is, of course, bounded by certain limits; there is, however, no limit but that of expense to the armour which may be placed upon fortresses. The embrasures especially require protection, and various shields have been proposed for this purpose. Thorneycroft's bars, although rejected in this country, have been supplied to the Russian Government for the defences of Cronstadt. A shield, the invention of Captain Inglis, R.E., has been found to give very satisfactory results. It consists of planks of wrought-iron crossing each other at right angles, the front layer being 6 inches, 7 inches, and 8 inches thick, and the rear layer 5 inches thick, secured through the centres by screw bolts with elastic washers under the nuts. This shield was fired at with a 300-pounder Armstrong gun and other heavy ordnance; but, though much shaken, it was not penetrated. The conditions of weight of armour for land fortifications being essentially different to those for ships, as above stated, it appears that a shield can be made to withstand any ordnance brought to bear on it. The problem is, to effect this at the least cost.

For the questions of the velocity necessary to penetrate armour plate, and the best form and material of shot, the reader is referred to the articles GUNNERY and PROJECTILE.

Iron Pyrites. Yellow sulphide of iron. A bisulphide of iron, composed of iron 28 + sulphur 32. It is a very common and abundant ore of the metal; it has hitherto been principally employed for the production of the sulphate of iron, or of *green vitriol*; but since the attempt to create a monopoly in the sulphur trade, it has been largely used for the preparation of sulphuric acid. [PYRITES.]

Iron Ships. [IRON ARMOUR PLATE.]

Iron-clad Ships. [IRON ARMOUR PLATE.]

Ironwood. The name given to the hard wood of various trees in different countries, and more particularly to the trees of the genus *Sideroxylon*. That of Bourbon is *Cupania Sideroxylon*; those of the Dutch East Indies, *Eusideroxylon Zuageri*, *Namia vera*, *Intsia amboinensis*, *Memecylon ferreum*, *Stadmannia Sideroxylon*, *Sloëtia Sideroxylon* and others; that of Morocco is *Argania Sideroxylon*; that of Norfolk Island, *Notelæa longifolia*; that of North America, *Ostrya virginica*. These names by no means exhaust the list of plants to which the term is applied.

Irony (Gr. εἰρωνεία, from εἴρων, *a dissembler*, as saying less than he thinks). In Rhetoric, the quality of style and of sentiment which Aristotle designates by this term is somewhat different from that which bears the same title in modern phraseology, being, in fact, only a subdivision of it. Irony, in his sense of the word, is an artful representation of qualities or things as less than they really are. Thus, among the various characters of the human mind as given by him, the εἴρων is one who affectedly conceals or depreciates his own good qualities. Quintilian gives to rhetorical irony a far more general sense, terming it *diversiloquium*, or the use of expressions contrary to the thoughts of the speaker. He also distinguishes it into two species, treating it as a trope or figure of speech where the opposition of thought to language extends only to a few words; a figure of thought, where it extends to a whole passage or discourse. The Socratic irony is employed in argument when one speaker affects to take the positions of the other for granted, in order adroitly to lead him into self-contradiction or obvious absurdity. In the ordinary sense, irony is a more delicate species of sarcasm, by which praises are bestowed where it is intended to convey the opposite sense of disapprobation; or assent is notified where the real object is to express dissent.

Irradiation (Lat. irradio, *I shine on*, from radius, *a ray*). The apparent enlargement of a strongly illuminated object. Thus a platinum wire raised to incandescence appears much thicker. The impression produced by light on the retina appears to be extended, though to an extremely small distance, round the image of the object formed by the lens of the eye. The 'new moon with the old moon in her arms' is an appearance due to irradiation, as also the apparent projection beyond the planet's disc of the polar snows of Mars.

Irrational. In Arithmetic, an irrational quantity or *surd* is one whose ratio to unity is not equal to that of any two finite numbers. Irrational quantities are met with in attempting to extract the roots of numbers: thus the square root of 2 is irrational; it may be *represented* by the symbol $\sqrt{2}$, but it can only be approximated to by actual calculation. The term *irrational* is also applied to algebraic expressions which involve fractional indices or radical signs; and an expression of this kind is said to be *rationalised* when, by the performance of suitable algebraic operations, its irrational form is made to disappear. Thus the equation

$$\sqrt{x} + \sqrt{y} + \sqrt{z} = 0$$

by obvious processes of transposition and involution may be made to assume the rational form,

$$x^2 + y^2 + z^2 - 2yz - 2zx - 2xy = 0.$$

Irreducible Case. [CUBIC EQUATION.]

Irreducible Equation. An algebraic equation, whose coefficients are rational functions of any known quantities, is said to be *irreducible* when the function which is equated to zero is not divisible by any function of lower degree whose coefficients are likewise rational functions of known quantities.

Irregular (Lat. in, neg., and regula, *a rule*). In Botany, having the parts which constitute one series in a flower, the petals for example, dissimilar in size and form.

Irregular Cadence. In Music, one which does not end upon the essential chord of the mode in which a piece is composed. [CADENCE.]

Irregular Troops. Troops enlisted, paid, and officered differently from the regular army, and in general subject to different rules of discipline. There are several regiments of irregular cavalry in India; in these the men provide their own horses, arms, clothing, and subsistence. The regiments are raised by voluntary enlistment, and the men must serve twenty years before they receive any retiring allowance.

Irrigation (Lat. irrigatio). The art of spreading water over lands artificially, and by means of surface drains or channels, as contrasted with watering by manual labour. In Great Britain and in analogous climates, irrigation is confined to grass land; but in warmer climates, such as those of Italy, Spain, India, &c., irrigation is considered to be essential to the production of large crops in every kind of field or garden cultivation. When any surface is to be irrigated, the supply of water that is to be used for this purpose is conducted to the highest point of the field, and it is thence led over the surface in open gutters, so as to run very slowly, and to sink into the earth as it proceeds. In general no great surface can be irrigated at the same time, and different parts of a farm or of a field must be irrigated in succession. In countries where this practice is universal, it often happens that one source of supply is common to two or more farms, the occupiers of which have the water on alternate days; but the rights of water are subjects of frequent dispute. In the south of France, and in Italy and Spain, abundant crops cannot be produced without irrigation, which forms a necessary part of the education of the agricultural engineer. Even the potato crop and madder are irrigated in the neighbourhood of Avignon; and in Tuscany, wheat, maize, beans, turnips, and every other crop that can be sown with the drill is watered from artificial channels; while in India the cotton, sugar, and indigo crops are considered to require irrigation. The practice is as old as human civilisation; and some of the first machines we read of in history are those for raising the waters of the Nile, Tigris, and Euphrates, for irrigating the lands upon their banks. Water, in short, is to the agriculture of warm climates what manure is to the cultivator of temperate latitudes; and the efforts of the wisest rulers have been at all times directed to securing a proper supply of it. The English government has lately encouraged vast works for this purpose in its Indian possessions, and these have already yielded enormous profits. The irrigation works of the Moors of Spain may still be referred to as models of that description of enterprise. The reader who may desire to study this subject thoroughly would do well to consult Baird Smith's works *On Indian Irrigation* and *On the Irrigation of the Madras Territory*; Nadault de Buffon's *Traité de l'Irrigation de l'Italie Septentrionale*, and his *Traité de l'Agriculture Hydraulique*. The article on 'Water Meadows' in the *Aide Mémoire* of the military sciences may be consulted for the bibliography of the subject. A description of the works upon the great Ganges canal would also repay the attention of anyone who might think fit to trace the progress of the art of irrigation: some of them are amongst the most gigantic hydraulic works ever executed, as for instance the Solani aqueduct, which has a clear waterway of 180 feet in width by 10 feet in depth, with a headway above the valley of the river traversed equal to about 30 feet. This work was executed by the late East India Company, which fully appreciated the importance of irrigation.

Irvingites. The name popularly given to the followers of Edward Irving, who died at Glasgow in 1834. This celebrated preacher drifted into a system of mysticism, in which the doctrine of a millennium, with the power of working miracles and speaking with tongues, bore a prominent part. After his death, this system was greatly developed by his adherents, who organised themselves into a body to which they have given the name of the 'Catholic and Apostolic Church.' The titles and gradations of their ministers are borrowed from the Hebrew hierarchy of angels, while their discipline and doctrine in some respects resemble those of the church of Rome.

Isadelphous (Gr. ἰσάδελφος, *like a brother*). In Botany, when the separate bundles of stamens in a diadelphous flower are equal or alike.

Isatimide. A crystalline yellow powder formed on passing dry ammonia into an alcoholic solution of isatin.

Isatin. The product of the oxidation of indigo by chromic acid. It occurs in beautiful rose-red crystals.

Isatis (Gr. ἰσάτις). A genus of *Cruciferæ* which yields one or two dye plants, *I. tinctoria*, the Woad, and *I. indigotica*, the Teinching of China. Woad is said to have been originally a native of South-eastern Europe, whence it has spread by means of cultivation, and become naturalised in Europe as far north as Sweden, and also in some parts of Asia. Before the use of indigo became common among European dyers, the blue colouring matter obtained from this plant was an article of great importance; but the introduction of indigo has almost entirely superseded it, and it is now only grown to a slight extent, and used chiefly by woollen dyers for mixing with indigo, in order to excite fermentation. It is generally prepared by grinding the leaves into a paste, which is then carefully fermented in heaps, and afterwards made into balls or bricks for sale. Small quantities of these balls are

annually imported from the Continent, amounting in 1869 to 200 cwt. The use of woad as a dye dates from very early times. Dioscorides, Pliny, and others, mention its use for dyeing wool; and Cæsar relates that the ancient Britons used it for staining their bodies—the word Britain being derived from the Celtic *brith* or *brit*, 'painted,' in reference to this custom.

I. indigotica is cultivated as a tinctorial plant in the north of China, where it is called *Tein-ching*, and takes the place of the indigo of the south. Its colouring matter is obtained by a process closely analogous to that employed in the preparation of indigo; but instead of being thoroughly inspissated, so as to form solid cakes, it is used by the Chinese dyers in a semi-liquid or pasty state. It is commonly employed for dyeing cotton cloth, to which it imparts a dark-blue colour.

Ischiocele (Gr. ἰσχίον, *the hip*, and κήλη, *tumour*). A hernial tumour at the foramen of the ischium.

Ischium (Gr. ἰσχίον). One of the bones of the fœtal pelvis, and a part of the *os innominatum* in the adult.

Ischnophonia or **Ischophonia** (Gr. ἰσχνοφωνία, from ἰσχνός, *thin*, and φωνή, *voice*). Terms used by pathologists to designate a thin or small voice, loss of voice, and imperfect speech or stammering.

Ischuria (Gr. ἴσχω, *I retain*, and οὖρον, *urine*). Retention of urine.

Iserine. A variety of Titaniferous Iron, found disseminated in Iron-sand near the source of the Iser, in Silesia.

Isethionic Acid. An uncrystallisable stable isomer of sulphovinic acid; formed when solution of ethionic acid is boiled.

Isinglass (Ger. häusenblase, *the air-bladder of the sturgeon*). A very pure form of *gelatine*, prepared from certain parts of the entrails of several fish. The best is derived from the sturgeon, and is almost exclusively imported from Russia, twisted up in rolls or formed into cakes, which are afterwards torn into shreds or cut into fine shavings in this country. Good isinglass should be free from smell and taste, and perfectly soluble in boiling water.

Isis. One of the chief deities in Egyptian mythology, the wife of Osiris and mother of Horus. She is, however, very variously described, and invested with many different characters. By the Greeks, she was generally identified with Demeter (Ceres). Among the higher and more philosophical theologians she was made the symbol of Pantheistic divinity: see especially the remarkable passage at the end of the *Golden Ass* of Apuleius. By the people she was worshipped as the goddess of fecundity, and in her honour an annual festival was instituted which lasted seven days. The cow was sacred to her. She was represented variously, though most usually as a woman with the horns of a cow, and sometimes with the lotus on her head and the sistrum in her hand. Her priests were bound to observe perpetual chastity; but when her worship passed into foreign countries, her rites became merely a cloak for sacerdotal licentiousness, which at last reached such a pitch that they were prohibited at Rome. The worship of Isis, however, was repeatedly revived, and furnished a theme for the indignant pen of Juvenal. The *Isiac Table* in the Turin Museum, which was so long supposed by the learned to represent the mysteries of Isis, 'has been judged by Champollion to be the work of an uninitiated artist little acquainted with the worship of the goddess, and probably of the age of Hadrian.' (Creuzer's *Mythol.*; Plutarch's *Treatise on Isis and Osiris*, &c. &c.; an Essay by De Montfauçon, *Hist. de l'Acad. des Inscr.* vol. xvi., which contains a summary of the Grecian learning on the subject; *Mém. de l'Acad. des Inscr.* xxxiv.; and *Quart. Rev.* July 1840.)

Isis (*Isidos proclamos*, a marine plant, like coral, according to Pliny). The name of a genus of jointed coral, in which the joints are composed of a substance resembling horn.

Islam or **Eslam.** The religion of Mohammed. The body of the faithful, and the countries in which it is professed, are so termed by the Mohammedans. All those who professed the true religion and the unity of God before the arrival of Mohammed, are considered as comprised in the character and privileges of Islamism. The Mufti of Constantinople, or chief minister of religion in Turkey, bears the title of Sheikh-ul-Islam.

Island (properly eye-land, from A.-Sax. eye, as in Athelney, Thorney; the word *isle* representing the Latin insula: Wedgwood s.v.). A tract of land encompassed with water, whether of the sea, a river, or a lake; in contradistinction to *continent* or *terra firma*.

Islands. The detached portions of land separated from each other, and from the larger masses or continents, by water spaces more or less wide and deep, are of two very distinct kinds. Some are elongated and generally parallel to continents, others are detached, rounded, or in groups and systems in open ocean. The former are called continental, and the latter pelagic. Of the continental islands of Europe, the British Islands, the islands between Italy and Spain, and those of the Grecian Archipelago are the most important. As connected with Asia and Africa, Formosa and the Japanese group, the New Zealand group, Madagascar and the islands of the Indian Archipelago, are the most characteristic; while the West Indian islands, Patagonia, and the chain of islands off the north coast of North America are illustrative examples.

Amongst pelagic or oceanic islands, may be quoted the various groups of the South Pacific Ocean, some of those in the Indian Ocean, the Canary Islands, and the Galapagos

Most groups of islands near continents have formerly been connected with the adjacent land, while the pelagic islands are probably

related to lands now either submerged or rising. Many of the latter are coralline or volcanic.

Islands of the Blessed (Lat. Insulæ Beatorum, Fortunatæ Insulæ; Gr. Νῆσοι Μακάρων). According to the Grecian Mythology, the Happy Islands, supposed to lie westward in the ocean, whither after death the souls of the righteous were transported. [ELYSIUM; HYPERBOREAN GARDENS.]

Ismaelians. A Mohammedan sect, who derived their name from maintaining the pretensions of Ismael, the son of Jaafar, to the rank of Imam, to the exclusion of Moussa, who was adopted by that saint. They consequently rejected the claims of Moussa and the five subsequent Imams. The Ismaelians formed a secret association, founded in the tenth century of the Christian era by Abdallah, a Persian. From them originated the famous society of the ASSASSINS. (Taylor's *History of Mohammedanism*, p. 225; *Mém. de l'Acad. des Inscr.* vol. xvii.; 'Secret Societies of the Middle Ages,' published in the *Library of Entertaining Knowledge*, 1837.)

Isocetic Acid. A constituent of the oil expressed from Euphorbiaceous plants. In the free state it occurs in pearly scales.

Isochimenal. [ISOTHERMAL.]

Isochromatic (Gr. ἴσος, *equal*, and χρῶμα, *colour*). Having the same colours. In certain experiments with doubly refracting crystals, the decomposed light forms a double series of coloured rings or curves of different forms, arranged in a certain order, each curve in the one series having one corresponding to it both in form and colour in the other. The two curves or lines which have the same tint are called *isochromatic*. (Herschel's 'Treatise on Light,' *Encyclopædia Metropolitana*.)

Isochronal Axes (Gr. ἴσος, and χρόνος, *time*). In Mechanics, axes around which, if a body be made to oscillate, the oscillations will be performed in equal times.

Isochronous. A term applied to two or more vibrations or oscillations to denote that they are performed in equal times. The term *isochronism*, as applied to a single vibrating body, denotes the property which it possesses of performing successive oscillations in equal times, notwithstanding the variation in the amplitude of those oscillations. The isochronism of the common pendulum is imperfect, but that of a cycloidal pendulum is theoretically perfect. [CYCLOID.] When the amplitudes are very small, however, the successive oscillations of a common pendulum are practically isochronous. The isochronism of a vibrating stretched string, again, is proved by the fact that the *pitch* of the note does not vary appreciably when its *intensity* diminishes.

Isoclinal Lines. Those lines which pass through places where the magnetic dip or inclination is the same.

Isodomum (Gr. ἰσόδομος, *built alike*). In Ancient Architecture, a species of walling, in which all the courses were of equal height.

Isogonic Lines (Gr. ἰσογώνιος, *equiangular*). In Terrestrial Magnetism, the lines passing through all places on the surface of the earth at which the horizontal magnetic needle makes the same angle with the meridian, or at which the *declination* is the same. [MAGNETISM, TERRESTRIAL.]

Isolated, Insulated (from the Ital. isola, Lat. insula, *an island*). In Electricity, a body is said to be isolated when it is surrounded by non-conductors, or bodies to which it cannot communicate its electric virtue, except by induction. Bodies may be isolated in various ways; by suspending them by means of caoutchouc or silken cords; by placing them on a cake of gutta percha, wax, resin, or sulphur, or on a stand of glass or dry varnished wood, &c.

Isolated Point. In Geometry, a double point at which the two tangents are imaginary. It is also called a *conjugate point*. [CONJUGATE POINT and DOUBLE POINT.]

Isomerism (Gr. ἴσος, and μέρος, *part*). Compounds which contain the same elements in the same ratio, and yet exhibit distinct chemical qualities, are said to be *isomeric*. The cyanic and fulminic acids are isomeric compounds of nitrogen, oxygen, and carbon. The distinctions thus arising are probably referable to the different ways in which the same elementary atoms are grouped in the compound. The ultimate elements of the hydrated cyanate of ammonia and of urea are the same, and in the same proportions, but the two substances are very distinct; the elements are differently grouped; they are carbon, hydrogen, oxygen, and nitrogen, and urea may be represented as $C_2H_4O_2N_2$, while in the cyanate they are arranged as NH_3,C_2NO,HO. To analogous cases in which the relative proportions of the elements in 100 parts by weight are the same, but in which the absolute number of atoms differs, the term *polymerism* has been applied. Aldehyd and acetic ether are liquids quite different in properties, but they are *polymeric*. Aldehyd is represented by $C_4H_4O_2$, and acetic ether by $C_8H_8O_4$. Two atoms of aldehyd would therefore be equivalent to one of acetic ether; but 100 parts of each liquid would yield precisely the same relative weights of carbon and hydrogen. At the same time these liquids are not mutually convertible into each other. In mineral chemistry, a similar condition presents itself in reference to the compounds known as ferro- and ferri-cyanogen. The former is Fe, C_6N_3; the latter has exactly double the number of atoms, F_2, $C_{12}N_6$. In a state of combination, their crystalline forms, colour, and chemical properties are wholly different. These facts teach us that the grouping of the atoms, apart from the composition of substances, has a material influence on their chemical and physical properties.

Isomerous (Gr. ἰσομερής, from ἴσος, and μέρος, *a part*). In Botany, equal in number. Thus an isomerous flower is one in which

the different parts are equal to each other in number.

[Isometric]al Perspective. [PERSPECTIVE.]

Isomorphism (Gr. ἴσος, and μορφή, *form*). Substances which resemble each other in their crystalline forms, but differ in their component parts, are said to be *isomorphous*. Thus the phosphate and biphosphate of soda have the same form, or are *isomorphous*, with the arseniate and binarseniate of soda; and in regard to other bases, such as potash and ammonia, each arseniate has a corresponding phosphate possessed of the same form. In these cases there is necessarily an analogy in the atomic constitution of the compounds, which are observed to possess the same number of equivalents of acid, alkali, and water of crystallisation, and differ in nothing except that the one series contains an atom of arsenic, and the other an atom of phosphorus.

Isonandra (Gr. ἴσος, *equal*, and ἀνήρ). The genus which yields the Gutta Percha tree, *I. Gutta*, which is a large forest-tree of the Indian Archipelago, growing sixty or seventy feet high, with a trunk two or three feet in diameter, and abounding in milky juice, which is Gutta Percha. The tree belongs to the order *Sapotaceæ*. The juice has been obtained by felling the trees, and through this extravagant mode it has become extinct in Singapore, whence the produce was first obtained. The average quantity yielded by each tree is set down at 20 lbs. For the uses and properties of this substance, see the article GUTTA PERCHA.

Isoperimetrical (Gr. ἴσος; περίμετρον, *circumference*). A term applied to figures, rectilineal or curvilineal, having equal perimeters. An *isoperimetrical problem* originally denoted one in which, of all possible isoperimetrical figures, that one was required which possessed some other assigned property or properties. As an example of an isoperimetrical theorem, to which the solution of such problems lead, we may cite the well-known one according to which the area of a circle is greater than that enclosed by any other isoperimetrical figure. The term *isoperimetrical*, however, was soon extended to a more general class of problems regarding the nature of the figure which, having certain properties in common with others, is distinguished from the latter by some maximum or minimum property.

James Bernoulli was the first who discovered the true principles on which questions of this kind depend, and the circumstances which render the ordinary methods of maxima and minima inapplicable to them. The immediate subject of his researches was the problem of the BRACHISTOCHRONE [which see], or curve of quickest descent, celebrated in the early history of the calculus on account of the controversy to which it gave rise between the two brothers, James and John Bernoulli. The analysis of the former, *Analysis magni Problematis Isoperimetrici*, was published at Basle in 1701, and in the *Leipsic Acts* of the same year. Solutions were afterwards given by Taylor in his *Methodus Incrementorum*; by John Bernoulli in the *Memoirs of the Academy of Sciences* for 1718; and by Euler in the *Petersburg Memoirs*. Euler afterwards gave a complete and general solution of the problem in his *Methodus inveniendi Lineas curvas maximi minimive Proprietate gaudentes*, a work of which Lagrange has said that there is perhaps no other which can be of more use to those who wish to exercise themselves in the integral calculus. The method, however, which is followed in this work has been superseded by the invention of the *calculus of variations* by Lagrange; a most important branch of analysis, of which the solution of isoperimetrical problems is one of the most obvious applications.

The purely geometrical treatment of isoperimetrical problems has been little cultivated. One of the ablest researches of this kind was given by Steiner in Crelle's *Journal*, vol. xxiv. 1842.

Isopoda (Gr. ἴσος, and πούς, *a foot*). The name of an order of Crustaceans, comprehending those which have the legs all alike, and adapted only for locomotion and prehension.

Isopodiform. The larvæ of Saprophagous Hexapods are so called which have an oblong body, a distinct thoracic shield, and a vent provided with filaments or laminæ.

Isopyre (Gr. ἴσος, *equal*, and πῦρ, *fire*; because the effect produced upon it by the blowpipe is like that produced on several other minerals). A silicate of alumina, peroxide of iron, and lime, found in compact masses in the granite of St. Just, near Penzance, in Cornwall. It is an amorphous mineral, resembling Obsidian, of a greyish or velvet-black colour, occasionally variegated with grey or red spots or streaks, like Bloodstone, and opaque or only slightly translucent.

Isosceles (Gr. ἰσοσκελής, from σκέλος, *a leg*). In Geometry, an isosceles triangle is one which has two equal sides. By Euclid's prop. 5, book i. the angles at the base of an isosceles triangle are also equal.

Isostemonous (Gr. ἴσος, and στήμων, *a thread* or *stamen*). In Botany, this term, in expressing the proportion that one part bears to another, denotes that the stamens are equal in number to the petals.

Isothermal (Gr. ἴσος, and θέρμη, *heat*). In Physical Geography, *isothermal lines* are those which pass through those points on the surface of the earth at which the mean annual temperature is the same. *Isothermal zones* are spaces on opposite sides of the equator having the same mean temperature, and bounded by corresponding isothermal lines. On account of the irregular form and disposition of the continental masses, by which the climate of different places is greatly influenced, the isothermal curves are not parallel to the equator, excepting in the very low latitudes. According to Humboldt, the isothermal line which corresponds to the temperature of 32° Fahrenheit

passes between Ulea in Lapland, lat. 66°, and Table Bay on the coast of Labrador, lat. 54°. The isothermal line of 41° passes near Stockholm, lat. 59½°, and St. George's Bay, Newfoundland, lat. 48°. The line of 50° passes through the Netherlands, lat. 51°, and near Boston in the United States, lat. 42½°; that of 59° between Rome and Florence, lat. 43°, and Raleigh in North Carolina, lat. 36°. In all these cases we see that the isothermal lines, in passing from the western side of the continent of Europe to the eastern coast of America, deviate very considerably towards the south; the deviation in one case amounting to 11½° of latitude. In passing over the American continent, they again recede to the northward; and in California, and to the north of that peninsula, along the western side of the continent, the annual temperature is nearly the same as under similar latitudes in the west of Europe. From the western to the eastern side of the old continent, the flexure of the isothermal curves and the diminution of the mean annual temperature under the same parallels are not less conspicuous. The isothermal line of 55° passes through Nantes, lat. 47°, and Pekin, lat. 39½°. Edinburgh and Kasan (in the east of Russia) have the same latitude; but the mean annual temperature of the former is 48°, while that of the second is below 38°. For the different causes which affect the parallelism of the isothermal lines, or which produce the differences of the mean annual temperature of places under the same parallel of latitude, see CLIMATE.

Humboldt gives the name of *isotheral lines* (Gr. ἴσος, and θέρος, *summer*) to the curves passing through those places at which the mean summer heat is the same; and of *isochimenal* (ἴσος, and χειμών, *winter*) to those which pass through the places at which the mean temperature of winter is the same. The isotheral and isochimenal curves deviate much more from the parallels of latitude than the isothermal. The latitudes of places having the same winter temperature sometimes differ as much as 18° or 20°. The winter of Scotland is as mild as that of Milan. The mean temperature of the winter months at Edinburgh is about 38½°; of Kasan, under the same parallel, only 2°. The winter of Pekin is as rigorous as that of Stockholm. (Humboldt's *Fragmens Asiatiques*; Murray's *Geography*, Introduction.)

Issuant. In Heraldry, a charge represented as issuing or coming up from another charge or bearing; also, a lion or other beast represented as rising from the bottom line of a chief.

Issue (Fr. issue, from the old verb issir = Lat. exire, *to go out*). In Law, in the most ordinary senses of the word: 1. The points in dispute in a suit at law between two parties, ascertained by the pleadings, are termed the issues; and are either issues in law, to be determined by the court, or in fact, to be ascertained by a jury. In each form of action a *general issue* may be pleaded, denying the whole cause of action, as that the defendant *never was indebted* as alleged, and in cases where this is not applicable, as where the case for the defence is that a debt once existing has been paid, or that a demand has been barred by the Statute of Limitations, the appropriate issue may be raised by a special plea. [PLEADING.] A *feigned issue* was a technical mode formerly used of trying some questions, supposing an imaginary wager. In the Scottish practice of trial by jury, it is usual to put printed copies of the issues into the hands of the jurors. 2. The legitimate offspring of a man.

ISSUE. In Surgery, an artificial ulcer. It is commonly made by wounding or cutting the skin, and placing a pea upon it, which is pressed upon the part by a bandage.

Isthmian Games. One of the four great national festivals of Greece; so called from their being celebrated on the isthmus of Corinth. They were common to all the states, with the exception in this case of the Eleans. They were held near a temple of Poseidon or Neptune, and were celebrated every third year, according to some accounts, but others assign them a period of one or four years. The contests were the same as in the other sacred games [OLYMPIC GAMES]: the victors were crowned with garlands of pine leaves.

Isthmus (Gr. ἰσθμός). In Geography, a narrow neck of land joining two continents, or a continent and a peninsula. Thus, the isthmus of Darien joins North and South America, and the isthmus of Suez connects Africa with Asia.

Itaconic Acid. An acid formed by the action of heat on *aconitic acid*.

Itaka Wood. The timber of *Machærium Schomburgkii*, a tree of British Guiana, a beautifully mottled wood employed for cabinet work, and also known as Tiger-wood.

Italian Architecture. [ARCHITECTURE.]

Italian Juice. The extract of Liquorice prepared in Calabria. That which is prepared on the estates of the marchioness of Solazzi, and known in commerce under the name of *Solazzi juice*, being so stamped, is the most esteemed. The *Spanish juice* is prepared in Catalonia.

Italian School. When the arts began to revive after the conquest of the ancient world by the barbarians of the north, they were cultivated with especial favour in the various states of Italy where the traditions of the Roman civilisation still lingered. Thus we find that in architecture the preference for the horizontal line over the vertical line was always a characteristic of the Italian art; and in the branches connected with sculpture and painting there was, even in the mediæval times, a great tendency to revert to the types of form adopted in the Roman and the Græco-Roman school. The processes of the Byzantine painters were even retained by their Italian rivals until the commencement of the thirteenth

century when Guido da Siena practised the art, and they were retained up to the time when Cimabue dared to strike out an original mode of expression. He was succeeded by Giotto, Puccio Capanna, Taddeo Gaddi, Orcagna, Starnina, Memmi di Firenze, Cavallini, Vitalis, Col Antonio del Fiore, Carlo Crivelli di Venezia, Mantegna, and Perugino, when the different sub-schools, into which Italian painting has been divided, began to be felt. The characteristics of the pure Italian school were: a simple and naïve expression of the principal figures, a great harmony of parts, and a tendency to keep the subordinate figures in the background, a gradual progress in the science of foreshortening, and a careful balance of colour; the drawing was gradually raised from mediæval simplicity to the elaborate perfection of Mantegna and Perugino, who made the decisive steps which led to the formation of the schools of Michael Angelo and of Raphael, and thus established the schools of Florence and of Rome. Ghirlandajo, Lippi, Paolo Uccello, Masaccio, Signorelli, may also be cited amongst the revivers of the taste for the arts, and they were well seconded in this particular branch by Lorenzo Ghiberti, who in the bronze castings for the gates of the Baptistery of Florence merited all the praise that Michael Angelo lavished upon him. There was a constant striving after the ideal amongst the artists of the Italian school, which forms a marked contrast with the desperately realistic tendencies of the contemporary artists of the German and Flemish schools. (D'Agincourt, *Histoire de l'Art par ses Monuments.*)

Italic School of Philosophy. This school comprehends properly the Pythagorean and Eleatic systems taken together; but sometimes it is used as synonymous merely with the school of Pythagoras. Under the several heads will be found the chief features of these philosophical systems. The Italic school has been so designated because its founder, Pythagoras, is said to have taught in Italy, spreading his doctrine among the people of Tarentum, Metapontum, Heraclea, Naples, &c.

Italic Types. In Printing, the elegant sloping types, the invention of which is due to Aldo Manuzio, the celebrated Venetian printer. [Aldine Editions.]

Itch (a word of doubtful origin). A disease of the skin, consisting in an eruption of minute itching vesicles, which are commonly rendered more inflamed and troublesome by scratching. They generally make their first appearance between the fingers, or about the bend of the wrist, and often spread to other parts of the body, especially where cleanliness is neglected. The itch is highly contagious, and is supposed to depend upon a minute insect burrowing in the skin; some have regarded the insect as a consequence, and not the cause, of the disease. The itch is cured by sulphur, which should be given internally, and applied externally in the form of ointment. When the smell of sulphur is objected to, ointments of white hellebore (*Veratrum*) and of white precipitate of mercury are frequently substituted, but they require to be cautiously used.

Itihasas. The two great heroic poems of the Hindus, the *Ramayana* and *Maha Bharata*, are so called. They are of great antiquity; later, however, than the *Vedas*. Some, indeed, have attributed the latter poem to a period later than that of Alexander.

Itinerary (Lat. iter, *a journey*). In Literature, a work containing notices or descriptions of the places and stations to be met with in pursuing a particular line of road; as, an Itinerary from Paris to Rome: or of the principal places and stations on the great roads throughout a country; as Itinerary of France, Italy, &c. The Latin Itineraries which have been preserved to us, and of which the most important is that of Antoninus, consist merely of catalogues of stations; and are principally valuable to us because they contain the distance, in Roman miles, from one to another, and thus furnish us with assistance towards determining the actual site of each place mentioned. The *Jerusalem Itinerary* describes the route and stations between Bordeaux and Jerusalem.

Itis. This termination, added to the root of the Greek name of an organ or part of the body, implies *inflammation* of that part; as, *gastritis*, inflammation of the *stomach*; *pleuritis*, of the *pleura*; *bronchitis*, of the *bronchia*, &c.

Ittnerite. Named after Ittner. A rare substance, which occurs at Kaiserstuhl in the Breisgau, massive and in rhombic dodecahedrons, of a grey or bluish colour. It is a complex mineral, containing silicate of alumina, sulphate of lime, sulphide of sodium, and about ten per cent. of water.

Iulidæ. The name of a family of Myriapods, having the iulus or gally-worm as the type.

Iulus (Lat.). A genus of Myriapodous insects, characterised as follows: Antennæ with seven joints, slightly enlarged towards the end; mandibles two, thick, without palps, each divided into two by a middle joint: provided with imbricated teeth; an inferior lip formed by the confluence of two maxillæ; feet attached in double pairs to most of the joints; body long, cylindrical, capable of being contracted into a discoidal spire. The common gally-worm (*Iulus terrestris*) is an example of this genus.

Ivory (Lat. ebur). The peculiar modification of dentine composing the tusks of the elephant. These are chiefly or solely developed in the male. Ivory is less brittle than bone, and of a beautifully uniform texture, admitting of turning in the lathe and receiving a high polish. It consists of about 24 per cent. animal matter resembling horn, and 66 of phosphate, with a trace of carbonate of lime. The chief consumption of ivory in England is in the manufacture of handles for knives; but it is also extensively used in the manufacture of musical and mathematical instruments, chessmen, billiard-balls,

plates for miniatures, toys, &c. Ivory articles are said to be manufactured to a greater extent, and with better success, at Dieppe, than in any other place in Europe; but the preparation of this beautiful material is much better understood by the Chinese than by any other people. No European artist has hitherto succeeded in cutting concentric balls after the manner of the Chinese; and their boxes, chessmen, and other ivory articles, are all far superior to any that are to be met with elsewhere.

The western and eastern coasts of Africa, the Cape of Good Hope, Ceylon, India, and the countries to the eastward of the straits of Malacca, are the great marts whence supplies of ivory are derived; but the most esteemed ivory comes from Africa, being of a closer texture and less liable to turn yellow than that which is brought from the East Indies. The medium weight of a tusk is about 60lbs.; and the average importation for the three years ending 1850 was 6,000 cwt., yielding a duty of 1*l.* per cwt.

Ivory Black. The mixture of charcoal and phosphate of lime obtained by burning bone is sold under this name, and, like other forms of animal charcoal, is very effective in depriving certain substances of their colour.

Ivory, Vegetable. The hard albumen of the nuts of *Phytelephas macrocarpa*, employed in the arts, especially for turnery purposes.

Ivory's Theorem. By means of this theorem, discovered in 1809 (*Encyclopædia Britannica*, art. 'Attraction'), Ivory reduced the determination of the attraction of an ellipsoid upon an external material point to the simpler problem of finding the attraction of a confocal ellipsoid upon an internal point. To facilitate the enunciation of the theorem, it is necessary to premise the definition of *corresponding points*. Two points, one on each of two confocal ellipsoids, are said to correspond when their distances from any principal diametral plane are proportional to the axes perpendicular to that plane. This being understood, Ivory's Theorem may be thus enunciated: The components of attraction, parallel to any axis, of two confocal homogeneous ellipsoids upon equal particles situated at corresponding points, are proportional to the areas of the principal sections perpendicular to that axis.

Ivy (A.-Sax. ifig). The common name of the *Hedera Helix*, a well-known evergreen shrub, which climbs over buildings and up the trunks of trees, mantling them with its glossy foliage.

Ixion. [TANTALUS.]

Ixolyte. A fossil resin, found in a bed of bituminous coal at Oberhart, in Austria.

J

J. As a letter, see I.

Jabiru. The name of a Grallatorial or wading bird belonging to the genus *Mycteria.*

Jaca or **Jack-tree.** The name of the *Tsjaca* or *Artocarpus integrifolia*, a species of bread-fruit, found in the Indian Archipelago. The wood of this tree is called Jack-wood.

Jacamar. A genus of Scansorial birds. [GALBULA.]

Jacana. The wading birds of the genus *Parra* are so called.

Jacchus (Gr. ἰάχω, *I cry*). A genus of Platyrrhine Quadrumana, or South American monkeys, with thumbs on the hind foot only; all the digits of the fore foot having the same direction, and being armed with narrow, curved, claw-like nails. The characters of the genus are: upper middle incisors separated from and larger than the lateral ones; lower incisors elongated, narrow, and vertical, the lateral ones the longest; upper canine teeth conical, and of moderate size, but more developed than the lower ones. The species of *Jacchus* are few in number, and not very clearly defined; they are all of small size. The *Jacchus penicillatus*, remarkable for the radiated tuft of white hairs which projects in front of each ear, has bred in captivity in this country. It is a very delicate little animal, provided with a long and bushy tail, which it wraps round its head and body when asleep or requiring warmth. Its food is of a mixed nature; but in the wild state the banana is said to be its principal and favourite nutriment.

Jacinthe (Fr.). [HYACINTH.]

Jack. Something shown, a signal. In this sense, the word is now limited in its application to the *Union Jack*, which is the distinctive badge of the United Kingdom of Great Britain and Ireland. [UNION JACK.]

JACK. A common name for the pike.

JACK. In Mechanics, an engine for raising heavy weights.

Jack is also the name given to a machine in common use for turning a spit. The common roasting jack, or worm jack, consists of a double set of wheels; a barrel, round which the chain attached to the weight or moving power is wound; a perpetual screw; and a fly, which secures a steady uniform motion. A multiplying wheel is usually added, in order that the weight may be longer in running down.

The *smoke jack* is used for the same purpose as the common jack, and is so called because it appears to be moved by the smoke of the fire. It is in fact moved by the ascending current of rarefied air, which acts on a fan properly placed in the chimney. The motion may be obtained by various contrivances. Sometimes

spiral flyers coiled about a vertical axis are employed, but more frequently a vertical wheel with oblique leaves like the sails of a windmill.

Jack or **Jacque of Defence.** A piece of defensive body armour worn in the fourteenth and fifteenth centuries. It appears to have been of four kinds: a quilted coat; or of leather and canvas in many folds; or formed of mail; or of small plates. It was sometimes covered with velvet and lined with silk.

Jack Sinkers. Parts of a stocking frame.

Jack Timbers. Those timbers in a bay which are intercepted by some other piece, and consequently are shorter than the remainder; thus, in a hipped roof, the rafters that are shorter than the side ones are called the *jack rafters*.

Jacks. Wooden wedges used in coal mines.

Jack-fruit or **Jaca.** [ARTOCARPACEÆ.]

Jackal (Arab. tschakkal, Fr. chacal). A wild species of dog, the *Canis aureus* of Linnæus, of gregarious habits. They hunt in packs, rarely attacking the larger quadrupeds, whose presence they are said to indicate to the lion by the piercing cries which they set up in chorus while scenting their tracks. They feed on the remnants of the lion's prey, on dead carcasses, and the smaller animals and poultry. The jackal interbreeds with the common dog; its period of gestation is the same, and the hybrid progeny is fertile. The wild jackal emits a highly offensive odour, which is scarcely perceptible in the domesticated animal. The *Canis aureus* is abundant in the warmer parts of India and Africa, but is not found in the New World, where it is represented by the Aguara dogs of Brazil.

Jackdaw or **Daw.** *Corvus Monedula* (Linn.). A common English bird, which frequents church steeples, old towers, and ruins, in flocks, where it builds its nest. The female lays five or six eggs, paler and smaller than those of the crow. The daw may be readily tamed, and taught to imitate the sounds of words. Like other species of the crow genus, they have the singular habit of stealing and hiding glittering and metallic substances.

Jacob's Ladder. In Botany, the name of the *Polemonium cæruleum*, a popular garden flower.

JACOB'S LADDER. In Naval affairs, a rope-ladder with wooden steps or spokes, by which the outside of the shrouds, and therefore the means of ascending the mast, is reached from the deck.

Jacob's Staff. The same as *cross-staff*. An instrument used by surveyors in measuring heights and distances where expedition and little accuracy are required.

Jacobian. A functional determinant whose line-constituents are the several first derived functions of a number of quantics in an equal number of variables. Thus the Jacobian of three ternary quantics u, v, w, is the functional determinant of the third order:

$$J = \begin{vmatrix} \frac{du}{dx}, & \frac{du}{dy}, & \frac{du}{dz} \\ \frac{dv}{dx}, & \frac{dv}{dy}, & \frac{dv}{dz} \\ \frac{dw}{dx}, & \frac{dw}{dy}, & \frac{dw}{dz} \end{vmatrix}$$

The Jacobian of a system of quantics is an important function which occurs frequently in the theory of elimination, and that chiefly in consequence of the property which it possesses of being reduced to zero by any system of values of the variables which simultaneously reduces to zero each of the given quantics. This same system of values, too, causes the several derived functions of the Jacobian to vanish, provided the given quantics are all of the same order. The Jacobian, it may be observed, is always a covariant of the system of quantics, since the operations

$$\frac{d}{dx}, \frac{d}{dy}, \frac{d}{dz}, \&c.$$

are contragredient to x, y, z, &c. [CONTRAGREDIENT; COVARIANT.] When the given quantics are the several first derived functions of one and the same quantic, the Jacobian coincides with the equally important function known as the *Hessian*, which of course is always a covariant of the quantic, and, together with its first derived functions, vanishes for the singular roots of the quantic. [SINGULAR ROOTS.]

The Jacobian, as its name implies, was first introduced by Jacobi; his celebrated memoir, *De Determinantibus Functionalibus*, will be found in Crelle's *Journal*, vol. xxii.

Jacobins. In Ecclesiastical History, the religious of the order of St. Dominic were so called in France, from the situation of the principal convent at Paris, near the Rue St. Jacques; also called *Frères Prècheurs*.

JACOBINS. In French History, a political club, which bore a well-known part in the first revolution. It was formed by some distinguished members of the First Assembly, particularly from Brittany, where revolutionary sentiments ran high. They took at first the name of Friends of the Revolution; but as at the end of 1789 they held their meetings in the hall of a suppressed Jacobin monastery in the Rue Saint Honoré, the name of Jacobins, at first familiarly given to them, was finally assumed by themselves. The history of the Jacobin club is, in effect, the history of the Revolution. It contained at one time more than 2,500 members, and corresponded with more than 400 affiliated societies in France. The club of the Cordeliers, formed by a small and more violent party out of the general body of Jacobins, was reunited with the parent society in June 1791, but continued to form a separate section within its limits. The Jacobin club, which had almost controlled the first assembly, was thus, during the continuance of the second, itself divided between two

contending parties; although the name of Jacobins, as a political party, is commonly given to that section which opposed the Girondists or more moderate in the club no less than in the assembly. After the destruction of the latter under the Convention, the club was again exclusively governed by the more violent among its own members, until the downfall of Robespierre. After that period it became unpopular; and its members having attempted an insurrection on behalf of the subdued Terrorists, Nov. 11, 1794, the meeting was dispersed by force, and the club finally suppressed. Some writers, such as Barruel (*Hist. du Jacobinisme*), have seen in the first formation of this and similar societies the long-concocted operations of a conspiracy against legitimate government and religion throughout Europe. The Jacobins, and the other principal clubs of the Revolution, adopted all the forms of a legislative assembly. In the constitution of 1792, their legal existence was recognised. See the historians of the French Revolution, especially Carlyle, Mignet, Thiers, Michelet, Louis Blanc, for general views; also Buchez and Roux, *Histoire Parlementaire de la Rév. Française*, for the most complete series of details respecting the Jacobins and their meetings which has yet been made public.

Jacobites. In English History, that party which, after the Revolution of 1688, adhered to the dethroned monarch James I., and afterwards to his descendants. In Scotland and Ireland, where the revolution was not effected except with the assistance of arms, the Jacobite party formed one of the two great divisions of each nation; and although crushed in the latter country by conquest, they continued in the former to comprise a large proportion of the population until long after the last rebellion in 1745. But in England the revolution was effected at first with the consent of all parties; the adherents of the exiled monarch were silenced; yet, in a year or two, the Jacobite faction rose into strength, and continued to harass the government of William throughout his reign. 'It seems undeniable,' says Hallam (*Constitutional History of England*, vol. iii. p. 149), 'that the strength of the Jacobite faction sprang from the want of apparent necessity for the change of government.' Its immediate cause, however, was to be found in the refusal of a portion of the bishops and clergy to take the oaths to the new government [NONJURORS], which gave, as it were, a certain consistency and tangible ground of opposition to the friends of the dethroned monarch in general. At the same time many of William's chief advisers and officers maintained a secret correspondence with James II. at the French court, less from any attachment to his cause than with a view to secure their own interest in case of his return. After the death of James II. in France, and the accession of Anne in England, the efforts of the party languished for a time; but towards the close of her reign they revived, on the prospect of a change in the succession. We have now undeniable proofs, from the French archives, of a fact which had been long suspected, that Bolingbroke and Oxford, with others of Anne's Tory ministers, were in treaty with the son of James II., and either really or in pretence negotiating for his return. In 1715, on the arrival of George I., broke out the unsuccessful first rebellion in Scotland; its ill conduct and failure proved a considerable check to the hopes of the English Jacobites. Bishop Atterbury, the last of their bolder intriguers and adherents, was banished in 1722, after which time it is probable that no extensive conspiracy took place on their part. In Scotland, however, the party maintained its strength, until the failure of the rebellion of 1745 put an end to its political existence. It is said that some of the party maintained a correspondence with Charles Edward, until his decease in 1787. The cardinal of York, his brother, died in 1807; and it has been said, that by his death the adhesion of the Jacobites, if any existed, was transferred to the reigning family as his next heirs. This, however, is an error; the royal house of Sardinia and other families intervening between the house of Brunswick and the crown of England, according to the strict rules of hereditary descent.

JACOBITES. In Ecclesiastical History, the Monophysite Christians of Syria are so called, from Jacob Baradzi, who revived their belief and form of worship in that country and Mesopotamia, in the middle of the sixth century. Many unsuccessful attempts have been made at various times to unite them with the church of Rome. (Gieseler's *Text-book*, transl. ii. 419, iii. 414 &c.) [MONOPHYSITES; EUTYCHIANS.]

Jacobus. A gold coin, so called from having been struck during the reign of James I. of England. It was worth twenty-five shillings, and weighed six pennyweights ten grains. The *Carolus*, valued at twenty-three shillings, weighed five pennyweights twenty grains.

Jacquard. A piece of mechanism applicable to silk and muslin looms for the purpose of weaving figured goods. The name is that of its inventor. (For a description of the loom, see Ure's *Dictionary of Arts and Manufactures*.)

Jacquerie. In History, the name popularly given to a revolt of the French peasantry against the nobility, which took place while King John was a prisoner in England in 1356. *Jacques Bonhomme* was a term of derision applied by the nobles to the peasants, from which the insurrection took its name. It began in the Beauvoisie, under a chief of the name of Caillet, and desolated Picardy, Artois, and Brie, where savage reprisals were executed against the nobility for their oppressions. It was suppressed after some weeks by the dauphin and Charles the Bad, king of Navarre. A similar spirit in England produced not many years afterwards the rebellion of Wat Tyler. (Méseray i. 838; Froissart; Sismondi, *Hist. des Français*, vol. x.; Hallam's *Middle Ages*, ch. i. part ii.)

Jactitation of Marriage. In Ecclesiastical Law, a suit brought against a party who declares that he or she is married. If the other party denies the fact, then, in absence of adequate proof, the person asserting the fact is enjoined to keep silence on that head.

Jade. In Mineralogy. [NEPHRITE.]

Jaggery. A kind of coarse sugar, made from the juice of the cocoa-nut and other Palms.

Jaguar. *Felis Onca* (Linn.). The largest and most formidable feline quadruped of the New World. It is marked with large dark spots in the form of circles, with a dark spot or pupil in the centre of each; it is generally pretty numerous in the neighbourhood of the large rivers where the capibara abounds, and preys chiefly on those large Rodents.

Jalalean Era. [GELALÆAN ERA.]

Jalap (so called from Xalapa in Mexico, whence it originally came). The dried root of the *Exogonium Purga*, and perhaps of some other species of *Convolvulaceæ*. This root occurs in irregular globular pieces of a dense and resinous texture: when reduced to powder it has a very peculiar and nauseous odour and taste. In doses of from five to twenty grains, jalap is a drastic purge: it is apt to gripe and nauseate.

Jalapine. The purgative principle of jalap root: it is a basic resin.

Jamaica Pepper. [ALLSPICE.]

Jambosa (from the native word Jambos). A Myrtaceous genus of Indian trees, many of which produce edible fruit, the most esteemed being the Malay Apple, *J. malaccensis*, and the Rose Apple, *J. vulgaris*. They are sometimes included in *Eugenia*.

Jambs (Fr. jambe). In Architecture, the side or vertical pieces of any opening in a wall, which bear the piece that discharges the superincumbent weight of the building or parts of the wall above them.

James, Saint, of the Sword. A very ancient military order in Spain and Portugal. The reigning kings are grand-masters in those countries respectively. The orders in the two countries were disunited in 1288.

James's Powder. *Pulvis Jacobi.* A mixture of bone-earth, or phosphate of lime, and oxide of antimony: it is often called *fever powder*, and acts as a diaphoretic, and also on the bowels, and sometimes causes nausea or vomiting, according to the dose in which it is exhibited. It is an uncertain remedy. The *pulvis antimonialis*, or *antimonial powder* of the London *Pharmacopœia*, intended as a substitute for James's preparation, is also open to the objection of uncertain activity, dependent upon the state of oxidisement of the antimony, the protoxide of that metal being virulently active, while the peroxide is comparatively inert. The usual dose of James's powder is from one to five grains. [ANTIMONY.]

Jamesonite. A sulphantimonite of lead. It occurs in acicular crystals in Cornwall, and is also found in Siberia, Spain, Brazil, &c. Named after Professor Jameson of Edinburgh.

Janissaries or **Janizaries** (a corruption of the Turkish words yeni tscheri, *new troops*). A celebrated militia of the Ottoman empire. The establishment of this corps has been usually attributed to Sultan Amurath I. in 1368; but the researches of Hammer (*History of the Ottoman Empire*, vol. i. p. 92) carry it back to Orchan, the conqueror of Nicæa (1326). This new corps was blessed by a saint of that time, Hadji Bektash by name, who cut off a sleeve of his fur mantle and gave it them as a token: whence was derived the fur cap that remained their distinguishing characteristic. This irregular infantry long remained the chief military strength of the empire, and formed a kind of warlike republic within its limits. It was supplied chiefly by the capture of young Christian slaves; and when under Mohammed IV. it began to be recruited principally from the children of the soldiers themselves, its power and importance gave signs of decay. Each regiment or oda of the Janizaries had its own soup kettle, which, in process of time, acquired a sort of prescriptive sanctity, and formed, as it were, the chief standard of the regiment; the officers and other military functionaries drawing their titles from their various supposed employments as cooks or kitchen servants. The militia of the Janizaries continued to retain a great influence in the empire itself long after it had ceased to be serviceable in the field against the armies of modern Europe. They controlled the sultans themselves, and, as it is alleged, presented a serious obstacle to all improvement, until in the year 1826 the sultan Mahmoud, on the occasion of a mutiny, dissolved the whole corps, after a bloody struggle in his capital in which 20,000 of them were said to have perished; but the number is now thought to have been exaggerated. An official publication relating to the destruction of the Janizaries was translated into French (Paris 1833). See also Walsh's *Residence at Constantinople*; Duval, *Deux Années à Const.* (1828); *Quarterly Review*, vol. xli.; *Edinburgh Review*, vol. l.; Slade's *Travels in Germany, Turkey, &c.* (1840).

Jansenists. A denomination of Roman Catholics in France, who followed the opinions of Jansen, bishop of Ypres, and formed a considerable party in the latter half of the seventeenth century. The Jansenists were Calvinistic in many of their sentiments, and in several respects approximated to the reformed opinions. They did not, however, separate themselves from the Catholic church; nor did they long survive the decree of Alexander VII., by which certain propositions extracted from their writings are condemned as heretical. The Jansenists are chiefly celebrated for their contest with the Jesuits, by whom they were at last overcome, and subjected to the enmity both of Louis XIV. and the Pope. (Leclerc, *Bibl. Univ.* vol. xiv.; Racine, *Hist. du Port Royal*; Fontaine, *Mém. pour servir à l'Hist. du P. R.*; Saint Simon, *Mémoires*; Palmer, *Essays on the Church* i. 320 &c.; Hallam, *Lit. of Europe*, vol. iii.; &c.)

Janthina, more properly **Ianthina** (Gr. ἰάνθινος, *violet-coloured*). A genus of Gastropodous Testaceous Molluscs, so denominated on account of the beautiful violet colour of the shell. There are but a few species of this genus known, all of which are marine, and are generally met with floating on the surface of the ocean in warm and tropical latitudes. The shell, as in all floating pelagic Testacea, is light and fragile, whence the specific name of the most common species (*Janthina fragilis*); but besides this relation of the shell to the habits and sphere of existence of the animal, each species also possesses a peculiar organ, by which it can, as it were, suspend itself to the surface of the water, and which has not hitherto been observed in any other molluscous species: this organ consists of a congeries of transparent vesicles filled with air, the parietes of the bubble-like cells being composed of a thin colourless condensed mucus, and the whole being attached to the posterior part of the foot. On account of this place of attachment, the vesicular float has been regarded as the analogue of the operculum, which otherwise is wanting; but there is an important difference connected with the float, viz. the power which the animal has, and frequently exercises, of detaching and reproducing it at will. Thus the mucous air-vesicles are cast off when the animal desires to sink: they are also made subservient to the reproductive economy of the janthina, which attaches its egg-cells to the under surface of the float, and when it is thus laden casts it off. By this means the ova are preserved in a situation where they may best receive the full influence of heat and light; and the power which the parent possesses of reproducing its float obviates the inconvenience which would otherwise result from this contribution to the well-being of its offspring. The following is the process by which the janthina has been observed to repair a mutilation purposely made in its float: The foot was advanced upon the remaining vesicles until about two-thirds of that part rose above the surface of the water; it was then expanded to the uttermost, and thrown back upon the water, like the foot of a Lymnea when it begins to swim; it next became contracted at the edges, and was formed into the shape of a hood, enclosing a globule of air which was slowly applied to the extremity of the float; there was now a vibratory movement throughout the foot, and when it was again thrown back to renew the process the globule was found enclosed in its newly made envelope. From this it results that the membrane enclosing the cells is secreted by the foot, and that there is no attachment between the float and the animal other than that arising from the nice adaptation and adjustment of the adjoining surfaces.

The genus *Janthina* belongs to the Pectinibranchiate order of Gastropods; the branchial cavity is capacious, and contains two pectinated gills. Cuvier places the genus between *Pyramidella* and *Nerita*; M. Roux considers it to be intermediate to *Ampullaria* and *Litiopa*.

January (Lat. Januarius). The first month of the year. By some the name is derived from Janus, a Roman divinity; by others from janua, *a gate*. It is said that the months of January and February were inserted in the Roman year by Numa Pompilius. (Sir G. C. Lewis, *Astronomy of the Ancients*, p. 38.)

Janus (Lat.). In Mythology, a Latin deity, represented generally with two faces looking opposite ways. But the name is only another form of Dianus, as Iana is for Diana. [DIANA.] The gate of Janus at Rome was kept open in time of war and shut in time of peace. It is said that this gate was closed only six times during 800 years, viz. once in the time of Numa, at the end of the first Punic War, thrice under Augustus, and once under Nero.

Japanning. The art of covering paper, wood, or metal with a thick coat of a hard brilliant varnish: it originated in Japan, whence articles so prepared were first brought to Europe. The material, if of wood or papier mâché, is first sized, polished, and varnished; it is then coloured, or painted in various devices, and afterwards covered with a highly transparent varnish or lacquer, which is ultimately dried at a high temperature and carefully polished. The basis of this lacquer, as used by the Japanese, is said to be a drying oil derived from a species of *Stagmaria*; but the Japan varnish or lacquer in common use is a solution of asphalt in oil varnish.

Jargoon. In Mineralogy, one of the varieties of *Zircon*, found in Ceylon.

Jarl. A word of Scandinavian extraction, signifying *noble*; applied in the early history of the northern European kingdoms to the lieutenants or governors appointed over each province. [EARL.]

Jarrah. A timber-tree of West Australia, the *Eucalyptus rostrata* of botanists. The wood is very durable, and resembles mahogany.

Jasher, or Jashar, Book of. A book to which reference is made in the Books of Joshua and Samuel. Lowth supposed that it was a collection of national songs, so called from the word with which it opened, Jasher, *he sang*. More generally the name has been taken to mean *the just*, the book being regarded as a record of the lives of righteous men. An account of the many opinions entertained of this book may be found in Horne's *Introduction to the Study of the Bible*. The most recent writer on the subject, Dr. Donaldson, in his work entitled *Jashar*, regards it as the nucleus round which the earlier Hebrew books have grown up, and as containing a pure and simple religion, which was afterwards designedly overlaid by the interpolations of a priestly caste, who had introduced the doctrine of the Fall, and an elaborate sacrificial system based upon that doctrine.

Jasminaceæ (Jasminum, one of the genera). A small natural order of Exogenous plants of the Echial alliance, with monopetal-

ous diandrous flowers of a regular figure. It contains few species, chiefly inhabiting the warmer parts of the world.

Jasmine (Arab. jâsamûn). The common Jasmine, *J. officinale*, is a hardy wall plant, with white flowers, beautiful as well as fragrant, and together with *J. grandiflorum* is principally cultivated in the south of Europe for purposes of perfumery.

Jason. In Mythology. [MEDEA.]

Jasper. A silicious mineral of various colours; sometimes spotted, banded, or variegated. It takes a fine polish, and the variety and richness of its colours render it useful in the ornamental arts.

Jateorhiza (a word coined from Gr. ἰατήρ, *a physician*, and ῥίζα, *a root*). A Menispermaceous genus closely allied to *Cocculus*, one species of which, *J. palmata*, formerly called *Cocculus palmatus*, furnishes the valuable medicinal root known as Calumba root. The plant is indigenous in the forests of Mozambique, whence the roots are imported.

Jatropha (a word coined from Gr. ἰατρός, *a physician*, and τροφή, *food*). A Euphorbiaceous genus, to which the Mandioc plant, from which Tapioca is procured, now called *Manihot utilissima*, was once referred under the name of *Jatropha Manihot*. It has also been called *Janipha Manihot*. Some of the Indian species yield oil by crushing the seeds. The Physic Nut, *Curcas purgans*, was also once referred to this genus. [CURCAS; MANIHOT.]

Jaundice. A disease characterised by a yellow colour of the eyes and skin, deep-coloured urine, and pale evacuations from the bowels; it comes on with languor, great depression of spirits, loss of appetite, dyspeptic symptoms, vomiting, bitter taste in the mouth, and generally pain in the region of the liver. It is apparently caused either by obstruction of the duct that conveys the bile into the intestine by a gall-stone; or by a morbid and viscid state of the bile, which prevents its flowing freely; or by spasm of the gall-ducts, or by some accidental pressure upon them, such as that exercised by masses of cancerous or other malignant disease: the consequence is, that the bile, instead of passing off by the bowels, is absorbed into the blood, and becomes visible upon the skin, especially in the more delicate vessels. It is an occasional consequence of pregnancy. It has been supposed to affect infants soon after birth; but the colouration is in such instances not produced by bile. The most common cases of jaundice are probably occasioned by viscidity of bile. Pathologists in the present day recognise a form of jaundice caused by the *retention* in the blood of certain of the elements of bile, a form produced quite independently of any pressure on the ducts. Aperients and small doses of blue pill, with tonics, are the most essential remedies; and where it occurs in persons of sedentary habits, moderate walking and horse exercise are requisite. It is often a protracted and troublesome complaint, and then indicative of structural derangement. Jaundice from gall-stones is often attended by excruciating pain and vomiting, owing to the passage of the stone. Opiates and such remedies as allay the irritability of the stomach are to be had recourse to, and the warm bath is useful. The beneficial influence of saline aperients and diluents in this disorder, has given celebrity to the waters of Cheltenham and similar mineral springs.

Javelin (Fr. javeline). A short spear thrown from the hand, anciently used both by horse and foot soldiers. The *pilum* of the Romans was of this description.

Jaws. In Sea language, the two sides forming the semicircular opening at the thick end of a gaff or boom. The object is to half encircle the mast, so that, the other half circle being completed with rope, the spar may at once be prevented from leaving the mast, and permitted to run up and down it when necessary.

Jay. The native bird so called is a species of the genus *Garrulus*, separated by Cuvier from the genus *Corvus* of Linnæus on account of the weaker mandibles terminating in a sudden and nearly equal curve. The tail is cuneiform, not long; and the slender feathers of the forehead can be erected like a crest. The common jay (*Corvus glandarius*, Linn.) nidificates in woods, and builds a simple nest of sticks and slender twigs; the female lays five or six eggs, of a greyish ash colour, mixed with green, and faintly spotted with brown. The young associate with the parents till the following spring, when they separate to form new pairs.

Jears. Strong tackle of blocks and stout ropes, for raising or lowering the lower yards in square-rigged ships.

Jeffersonite. In Mineralogy, a species of *Pyroxene*. It is found in New Jersey.

Jehovah. A name for the Deity in the Hebrew Scriptures. The word itself, which appears to be of Phœnician origin, was held in peculiar veneration by the Jews, who never allowed themselves to pronounce it in the reading of their sacred books, but substituted for it wherever it occurred, the term Adonai, or *Lord*. This practice is maintained even to this day; nor will they *write* the word in perfect Hebrew letters. Hence they have left the word Jehovah imperfectly written over the altar-piece in the synagogue in St. Helen's Place; making it to resemble that word, but in reality to signify *the Beloved*.

Jejunum (Lat. jejunus, *empty*). The second division of the small intestines; so termed because when examined after death it is generally found empty or nearly so.

Jelly. [GELATINE.]

Jerboa. [DIPUS.]

Jerfalcon. The *Falco Gyrfalco* of Linnæus.

Jervin (from *Jerva*, the Spanish name of a poison obtained from white hellebore). A crystallisable alkaloid, existing along with *veratria* in the root of *veratrum album*, or white hellebore.

Jess. In Falconry, the strap by which the leash is fastened to the leg of the falcon.

Jesuates of Saint Jerome. A religious order, founded in 1363 by Giovanni Columbino, of Sienna. It was suppressed by Clement IX. in 1668.

Jesuit's Bark. [CINCHONA; PERUVIAN BARK.]

Jesuit's Drops. The *compound tincture of benzoin* of the *Pharmacopœia*: called also *Friar's balsam.*

Jesuit's Powder. Powdered Cinchona bark.

Jesuites de Robe. A name applied to secular persons of high rank bound to the order of Jesuits by vows of obedience, without, however, having taken the spiritual vow.

Jesuits or **The Society of Jesus.** The most celebrated of all the Romish religious orders; founded by Ignatius Loyola, a Spaniard, in the year 1534, when he, with Francis Xavier, and four or five other students at the university of Paris, bound themselves to undertake the conversion of unbelievers. The first principle of the society thus formed was implicit submission to the commands of the Holy See: in consideration of which their order was confirmed in 1540 by Pius III.; and from that time to the present, though with many alternations of success and reverse, the Jesuits have been one of the main bulwarks of the authority of the Roman See. The zeal which they manifested at the period immediately succeeding the Reformation, when the Dominicans and other orders which had been founded on similar principles, and had faithfully executed their mission for many ages, had degenerated into luxury and indifference, secured for them the favour of the sovereigns and other political partisans of Rome. They soon became installed in the confessionals of all the Catholic kings of Europe, and throughout the sixteenth and following century were in fact the directors of their counsels and the rulers of their subjects.

In Protestant countries they acted as the emissaries and spies of the Pope; and in England, where early in Elizabeth's reign their landing upon our shores was made a capital crime, they persevered nevertheless in keeping alive the spirit of Roman Catholicism among the harassed remnant of the old faith. They passed and repassed the channel year after year, devoting their lives, with almost a certainty of eventually suffering, to the maintenance of an illegal, and often a treasonable, correspondence with the court of Rome and the enemies of the queen's government. At the same time another division of their numerous body employed themselves with the most undaunted energy, and with an apparent success such as has never crowned the efforts of any other missionaries, in converting the heathen of Asia and America. St. Francis Xavier, the Apostle, as he is called, of the Indies, planted Christianity in Hindustan and Japan; Ricci introduced it into China. In the course of a few years the number of professing Christians in these countries became very large. It should be remarked, however, that the great secret of their success seems to have been the address with which they obtained the confidence of the ruling powers. In Japan and China they became the intimate advisers of the sovereign, and frequently obtained the assistance of the civil power in the furtherance of their missionary system.

The Jesuits obtained also, throughout Roman Catholic Europe, the direction of the education of youth: they founded many schools and colleges, not only for the instruction of those who were designed for members of their own order, but for that of the upper and lower classes generally, in the education of both of which they were eminently successful.

As a religious body, the Jesuits differ from their predecessors, inasmuch as, their principle being to conform as much as possible with the manners of the age, they have never adopted the austere observances and exclusive spiritual character upon which all earlier orders had grounded their claims to notoriety. They are divided into different classes; of which only *the professed* take the religious vows of poverty, chastity, and obedience to their superior. Among the novices are frequently enrolled influential laymen, as was Louis XIV. himself in his latter years; and this is one of the means which the order has employed to extend its efficiency where it would be least liable to observation. The *professed* are of several ranks, the whole body being under the absolute control of the General, whose abode is fixed in Rome, and whose council consists of an admonitor and five assistants or councillors, who represent the five principal Catholic states—Italy, Germany, France, Spain, and Portugal. To Rome, as the central seat of the order, are sent monthly communications from the superiors of the different provinces through which its members are distributed.

The Pope has conceded to the Jesuits greater indulgence than even to laymen, exempting them from the religious observances which are enjoined on all Roman Catholics, and especially on the religious orders; and hence it is that they have been enabled to devote so great a portion of their time not only to instruction, but to many branches of learning and practice, by means of which they have insinuated themselves into the confidence and the concerns of the laity. They are remarkable also for the worldly air which when occasion serves they studiously assume—for the ease with which they dispense with all the outward appearance of their spiritual character in places where their objects seem to be more attainable by a different behaviour; and they have been reproached at all times with allowing themselves on the same principle to make use of mental reservations and other *pious frauds* in pursuance of the peculiar ends of their society. Hence, even when their influence in Europe was at its height, great distrust was manifested

towards them in many quarters. In France they were supposed to be implicated in the plots by which Henry III. fell, and the life of Henry IV. was attempted, and were indeed banished from that country by royal decree before the end of the sixteenth century: they were re-admitted, however, and continued in the enjoyment of their full influence in spite of the strong opposition of the Jansenists in the reign of Louis XIV. They were banished, in the course of the eighteenth century, from France, Spain, Portugal, and other Catholic states; and in 1773 Clement XIV. issued a bull by which he decreed the total abolition of the order. The invitation, however, of Catherine II. into Russia, and the favour of the successor of Clement, restored them in some degree; and they still exist and exercise considerable influence in Italy and Spain. From Russia they are at the present moment entirely banished; nor has Portugal readmitted them since their expulsion in 1759. In France and Germany their presence appears to be connived at, though they have never formally been allowed to re-establish themselves in those countries. In England they have been allowed to found and maintain the Roman Catholic college at Stonyhurst. By the Roman Catholic Relief Bill, natural-born Jesuits are required to register themselves with the clerk of the peace in every county: foreigners must provide themselves with licenses from a secretary of state; but these provisions have never been enforced.

The history of the Order of Jesus has often been written; but with so much exaggeration, both of friends and enemies, that it is difficult to point out a fair account. The *Historia Jesuitica* of Hospinian, a Protestant, carries it down to the end of the sixteenth century. Orlandi and Sacchetti's *History of the Jesuits* was proscribed by the parlement of Paris; a fifth part was added to it by Souvency. Coudrette, one of the order, published a history of it just before its dispersion, 6 vols. 12mo. with Supplement, 1761–4. D'Alembert published an account of the destruction of the order in France, 1765. See also Georget's *Mémoires*, Paris 1817. The celebrated *Lettres Provinciales* of Pascal contain a powerful exposure of the errors of the casuistical theologians of the sixteenth and seventeenth centuries, of whom a large proportion were Jesuits. The voluminous French collection, entitled *Nouvelles Ecclésiastiques*, continued from the reign of Louis XIV. to the Revolution, was under the management of Jansenists, and contains every charge which hostility could suggest against the Jesuits. Ranke's *History of the Popes of the Sixteenth and Seventeenth Centuries* contains much valuable matter relative to that period.

According to the most recent accounts, the order numbered in 1862, 7,231 members, of whom 2,203 were French, 1,635 Italian, 740 Spanish or Portuguese, 563 German, 512 Belgian, 349 Austrian, 265 English, 126 Irish, 240 North American.

Jet. A variety of Lignite. Some jets admit of polish, and are used for ornamental purposes. The jet found in the Lias of Whitby in Yorkshire is employed in making ornamental articles of mourning.

Jet d'Eau (Fr.). A fountain which throws up water to some height in the air. According to the theory of hydrostatics, the velocity with which water issues from an orifice is equal to that which would be acquired by a heavy body in falling through a height equal to the difference between the levels of the orifice and the fountain head; whence, if the resistance of the air and other impediments were removed, the height of the jet would be equal to that of the surface of the reservoir. Among the causes which prevent the jet from obtaining the height which theory assigns to it, the following are the principal: 1st. The resistance of the air, which is proportional nearly to the square of the velocity. 2nd. The friction against the sides of the pipe and the orifice through which the water issues. 3rd. The velocity of the particles diminishing at every instant as they ascend, the lower particles of the ascending column press against those next above them; and the pressure being by the nature of fluids communicated in all directions, the consequence is that the column is enlarged and proportionally shortened. 4th. The water at the top of the jet does not fall off instantaneously when its velocity is destroyed; it rests for a moment at the top of the column, where its weight opposes an obstacle to the particles next succeeding, and the retardation thus caused is communicated to the whole column. This last obstacle may be avoided by slightly inclining the jet from the vertical; and it is found by experience that a jet so inclined plays higher than one quite upright, though the effect is thereby rendered less pleasing. It is necessary that the diameter of the adjutage or orifice be considerably less than that of the pipe. (Desaguilier, *Experimental Philosophy*; Mariotte, *Mouvement des Eaux.*)

Jeterus. Vegetable jaundice, a disease of plants, where the system becomes affected with a general yellowness.

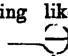
Jetsam. [Flotsam.]

Jetty (Fr. jetée). A landing place carried out from the bank of a river, or from the seashore, so that vessels may be enabled to discharge their passengers or cargo at all times of the tides. They may be either solid, so as to act as a species of breakwater, as is the case in the harbours upon the seacoast; or they may be made so as to allow the tide wave to flow uninterruptedly past them, as is the case in the various jetties upon the banks of the Thames. In hydraulic engineering, the two arms of a port are always spoken of under the name of *jetties*; they may be of wood, stone, or iron.

Jew Stone. The fossil spine of a large egg-shaped echinus.

Jew's Ear. The popular name of a cup-shaped tough but gelatinous fungus, velvety without and wrinkled within, to which botanists give the name of *Hirneola* or *Exidia*

Auricula Judæ. It was formerly employed in gargles, but its virtues seem to be imaginary.

Jew's Harp. An instrument of metal, with a flexible vibratory thin metal tongue fixed to its circular base; on which tongue the breath, acting in different degrees of force, produces something like a modulated air. It is shaped thus, . The outer bars are placed between the teeth, and the central piece or tongue is set in vibration by the action of the fingers.

Jew's Pitch. *Asphaltum.* [ASPHALT.]

Jezids. A sect of religionists, long settled in the mountainous country near Mosul; said to be disciples of Yezid Ben Anisa, a Mohammedan doctor. Their religion, however, is said to be a mixture of the ancient Manichean belief of those regions with the tenets of Mohammedanism and Zendism. They appear to be on better terms with the Christians than with the neighbouring Turks, by whom they are characterised as worshippers of the devil (Arab. *Scheitan*), whose name, it is said, no threats of punishment will force them to pronounce, and whom they only mention by periphrases, as *the great sheikh*, or *he whom you know of.* They live in villages, huts, and tents, and are dreaded for their ferocity and robber-like habits. They are noticed at length in a preliminary dissertation to Sylvestre de Sacy's *Description du Pachalik de Bagdad*, 1809; said to be the work of Father Garzoni, who was eighteen years a missionary in Kurdistan. (See the art. 'Jeziden' in Ersch and Gruber's *Encyclopædia.*)

Jib. A large triangular sail between the fore-topmast head and the jibboom in large vessels, and between the masthead and bowsprit in schooners, cutters, and other small craft. When the wind is a-beam, the jib serves to counteract the tendency of the driver to bring the ship's head towards the wind.

The effect of this sail would seem to be to lift the ship's head; yet seamen find that as the wind freshens it causes the ship, on the contrary, to plunge, and they either *ease it in* (along the boom), or haul it down. This anomalous effect may be explained as follows:—

Let x and z be the horizontal and vertical coordinates of the centre of effort, the centre of gravity of the vessel being the origin: let P be the resultant of the pressures on the sail. This may obviously be resolved into three; δ the direct effort along x, λ the lateral effort along y, and ρ the vertical effort in z. The moment to raise the bow is $x\rho - z\delta$. If $z\delta$ exceed $x\rho$, the effect is negative or tends to depress the bow. In all vessels $x > z$, also $\delta > \rho$ generally; hence the effect is not so decided as it may appear at first to be.

Let ϵ be the angle which P makes with the horizon, and ϕ be the angle between x and the horizontal projection of P; then $\rho = \mathrm{P} \sin \epsilon$, and $\delta = \mathrm{P} \cos \epsilon \cos \phi$: hence the effect is

$$\mathrm{P}\,(x \sin \epsilon - z \cos \epsilon \cos \phi).$$

When the wind is aft, $\phi = 0$, and $\epsilon = 90 - \kappa$ (the inclination of the jib-stay to the horizon nearly); and the effect is

$$\mathrm{P}\,(x \cos \kappa - z \sin \kappa),$$

which, as $\kappa = 45°$, is positive or lifting.

When the wind blows fresh, the vessel being close hauled and heeling over, the stay *sags* to leeward; and the after-leech being also slacker than the foot, the resultant P may become horizontal or $\epsilon = 0$, or even negative; in which last case the effect is

$$-\mathrm{P}\,(x \sin \epsilon + z \cos \epsilon \cos \phi),$$

which is altogether depressing. If now the jib be eased in, x and z are diminished. Hence, in general, the plunging effect of the jib is owing to the heeling of the ship, and to the sheet being too flat aft. The like reasoning obviously applies to staysails.

Jib Door. In Architecture, a door so constructed that it stands flush with the adjoining face of the wall on both sides, and without dressings or architraves. Thus it appears to form part of the wall, the intention of a jib door being simply to disguise the aperture.

Jibboom. On Shipboard, a movable spad running out beyond the bowsprit for the purpose of affording a base to the jib in large vessels, and to the flying jib in vessels of a smaller size from schooners downward.

Jibing. [GYBING.]

Jig. In Music. [GIGA.]

Jigger. On board Ship, a tackle having a block and a sheave at its respective ends, used in keeping the cable taut after being thrown off from the capstan, round which it has not taken more than two or three turns.

Jinjal or **Gingal.** A large musket used as a wall-piece in China and India.

Jobs. In Printing, cards, shop bills, reward bills, play bills, posting bills, auctioneers' catalogues, price lists, and other small things of a similar kind. Job houses seldom execute book printing to any great extent, as their materials are not calculated for it.

Joggle Piece. In Architecture, a truss post whose shoulders and sockets receive the lower ends of the struts, which are framed into them with a joggle joint.

Joggled Joints. In Architecture, the joints of stones or other materials, indented in such a way that the adjacent stones fitting into the indentations, they are prevented from being pushed away from each other by any forces perpendicular to the pressures by which they are thus held together; joggle joints give lateral stiffness to the assemblage.

Jogues or **Yugs.** Eras of extraordinary length in the mythical chronology of the Hindus. They are four in number, and are called respectively Suttee, Tirtah, Dwapaar, and Collee. In character they answer closely to the Hesiodic ages in Greek mythology. [SARUS; SOTHIAC PERIOD.]

John Bull. This well-known collective name of the English nation was first used in a satire (confidently ascribed to Arbuthnot,

though not actually avowed by him), *The History of John Bull*, usually published in Swift's works; in which the French are designated as Lewis Baboon, the Dutch as Nicholas Frog, &c.

John Dory (Fr. dorée, *gilt*, in reference to its yellow colour). In Ichthyology, *Zeus Faber*, the best known example of the Dory family of fishes, grouped by M. Valenciennes as the fifth great tribe of Scomberoids. In Gascony the John Dory is known by the name Jan, which signifies *cock*. It is possible, therefore, that the name John may be a corruption of this word, and not of the French jaune, *yellow*, which would be only a repetition of the epithet *dorée*.

Joinery. In Architecture, the art of framing woodwork for the finishing of houses, such as doors, sashes, shutters, cupboards, &c. The term *carpentry* is applied to the woodwork of a building which is of rough nature, and can be prepared with the axe, adze, chisel, and saw.

Joint Tenancy. In Law, where lands and tenements are granted to two or more persons to hold in fee simple, fee tail, for life, for years, or at will, without any words separating the title to their shares. Its properties are said to be unity of interest, of title, of time, and of possession; and it is subject to the right of survivorship. Joint tenancy may be severed by partition, or by the alienation of any party, but not by will. Personal chattels may be the subjects of a joint tenancy.

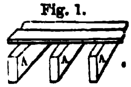
Joint-stock Companies. In Mercantile Law, joint-stock companies are now reducible to three classes: 1. Trading companies, incorporated by special Acts of Parliament, of which railway companies form the most important division, although companies formed for many other purposes have been incorporated by special Acts. 2. Companies established under the general Acts for regulating public companies which have been passed from time to time; the principle now generally accepted of limiting the liability of individual shareholders to the amount of their shares having been gradually introduced and worked out by successive amendments of the law. The last general Act is the Companies Act 1862, under which seven or more persons, under certain conditions, may form themselves into an incorporated company either with or without limited liability. 3. Mining companies on the cost-book system. The winding up of companies, either voluntarily by arrangement among the members, or compulsorily in case of insolvency, or in other ways failing to fulfil the conditions of their incorporation, is also provided for by Acts of Parliament. [COMPANY.]

Jointure. In Law, a settlement of lands and tenements made on a woman in consideration of marriage, ordinarily an estate for life; but the term is now usually applied to the more common provision of a rent charge. [MARRIAGE, LAW OF.]

Joists. In Architecture, the timbers of a floor to which the boards or the laths of the ceiling are nailed. They rest either upon the side walls, or upon girders, or sometimes upon both.

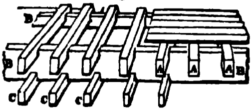
Where one tier only of joists is used, it is called a *single flooring* (fig. 1), A A A being the joists; and in this flooring the joists should not exceed sixteen feet in length, or bearing; and even when the bearing exceeds eight feet, they should have stiffening pieces to resist the action of torsion to which they are exposed; herringbone strutting is frequently employed with this object.

Fig. 1.



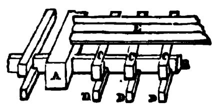
When two sets of joists are used, the floor is said to be a *double floor* (fig. 2), in which A A are called the *floor* or *bridging* joists; B B the binders; C C C the ceiling joists.

Fig. 2.



If the binding joists be framed into girders, the floor is then properly speaking a *double framed floor*, of which the sketch in the margin is the diagram (fig. 3). A is the girder; B, a binding joist; C C C are the bridging joists; and D D D are the ceiling joists; E being the floor boards. Of this floor, it is manifest that the girders are the main supports. The weight that ought to be put upon the joists of a building of course varies with the purpose for which it is intended; but in practice it is customary to calculate upon a weight of 112lbs. per foot superficial for ordinary houses, twice that weight for bridges, and four times that weight for railway bridges.

Fig. 3.



Jolly Boat (Dan. jolle, Dutch jol, *a yawl*). A broad safe boat on board ship specially devoted to the purposes of the steward.

Journal (Ital. giornale, from Lat. diurnus, *daily*). Strictly, a record or account of daily occurrences. It is more extensively employed to signify a narrative, periodically or occasionally published, of the transactions of a society, &c.; as by ourselves in the phrase 'Journals of the Houses of Parliament,' &c. It is also used as synonymous with *magazine*, or other periodical publications of that class.

JOURNAL. The neck, or bearing part, of a shaft that works in a plummer block, upon which the shaft turns and is supported. The amount of friction depends upon the proportions of this part of the machinery, which is, therefore, kept within narrow dimensions.

Joust (Ital. giostrare, Fr. jouster, jouter, *to tilt*). A term meaning in its primary sense the charge of a single horseman against a single antagonist, as distinguished from the tourney, the onset of a troop. The military games so called were very popular in the middle ages. Froissart gives many instances of the joust.

Juba (Lat. *a mane*). The long and thickset hairs which adorn the neck, chest, or spine of certain quadrupeds.

Jubaea. The Coquito Palm of Chili, very abundant in Central Chili, where a syrup called *Miel de Palma*, or Palm Honey, is prepared by boiling the sap to the consistency of treacle.

Jubé. The French name for a *rood screen*; this word is now very frequently employed in English works upon Architecture. Amongst the most celebrated works of this kind are, the jubés of Troyes, of Dixmude, of St. Étienne du Mont, in Paris, &c.

Jubilate (Lat. *rejoice*). A name given to the third Sunday after Easter; because on that day divine service was commenced with Psalm lxvi. 'Jubilate Deo, omnes terræ' ('Sing to the Lord, all ye lands').

Jubilee (Lat. jubilo, *I rejoice*). The name given among the Jews to the grand sabbatical year, which according to the Levitical law was to be celebrated after every seven septenaries of years as a year of general release not only of all debts, like the common sabbatical year, but of all slaves, and of lands and possessions which had been alienated from their original owners. The later Jewish history seems, however, to furnish no evidence of the observance of this enactment. The idea that the jubilee was intended to be typical of the release and redemption of mankind under the Gospel dispensation, led Pope Boniface VIII., at the end of the thirteenth century, to proclaim a general indulgence to all Christians who should visit the tombs of the Apostles at Rome in the secular year 1300. At this period it was intended that the same celebration should take place only every hundredth year. In consequence, however, of the enormous afflux of pilgrims which this proclamation brought together, and the gain which resulted from it, Clement VI. abridged the interval to fifty years; and the solemnity then received the name of the jubilee in imitation of the Jewish custom. The second jubilee was accordingly solemnised in 1350. In 1389, Urban V. reduced the term to thirty-three years, the number of the life of our Saviour: it was raised again by Nicholas V. to fifty; and finally, in 1470, fixed by Paul II. at twenty-five; and the jubilee has ever since been solemnised every quarter of a century, beginning on Christmas-eve, when the Pope opens with pomp the great door of St. Peter's, which is closed except on that occasion.

Judaism. Attachment to the rites of the Jewish law. The Judaising spirit of many of the early Christians is noticed in several of St. Paul's Epistles (especially that to the Galatians), and continued for a long period to exercise much influence on the character of the religion. (Milman's *History of Christianity*, vol. i. 21, 451, &c.)

Judge Advocate General. The adviser of the crown in matters of military law. He is a barrister, a member of parliament, and of the privy council. The proceedings of all district, garrison, and general courts-martial are submitted to the judge advocate general for approval; the latter being laid before the queen by him for confirmation. A deputy judge advocate is appointed to attend at all general courts-martial, and advise the court on points of law.

Judges (Lat. judex). In Jewish History, certain supreme magistrates who presided over the Israelites down to the reign of Saul. They were so called because they formed at once the civil and the military governors of the people. The dignity was retained for life, though it was not always hereditary. The history of the Book of Judges seems to show that they were chosen from the tribes which happened, for the time being, to have the preponderance.

Judgment (Lat. judicium, Fr. jugement). In the Fine Arts, the faculty of selecting that which is most suitable to the purpose.

Judgment. In Law, the sentence pronounced by the court upon the matter contained in the record. The term *judgment*, in English legal language, is restricted to the decisions of a court of common law: those of a court of equity are denominated *decrees*. Judgments are said to be of four sorts: 1. Judgments in law (on demurrer, where the facts are confessed upon the pleadings); 2. Judgments in fact (on the verdict of a jury); 3. Judgments by confession or default, i.e. where both facts and law are admitted by the defendant; 4. Judgments on a nonsuit or retraxit, where both fact and law are admitted by the plaintiff, who thereupon withdraws his claim. Judgments are also said to be either interlocutory, on matters arising in the course of the proceeding; or final, on the merits of the case. Judgments, when obtained, must be signed by the proper officer, and entered of record, without which they are not judgments. Arrest of judgment arises from error appearing upon the face of the record; but such error must now be, generally speaking, in substantial matter of law, and not on mere matter of form. When final judgment for a debt has been obtained, it becomes in law a *judgment debt*, on which interest at 4 per cent. per annum is chargeable, under 1 & 2 Vict. c. 110.

Judgment. In Logic, this term denotes the second of the three logical operations of the mind, which compares together two of the notions which are the subjects of simple apprehension, and pronounces that they agree or disagree with each other. Judgment, therefore, is either affirmative or negative; and the subjects of judgment are *propositions*, which are expressions of the agreement or disagreement of one term with another.

Judica (Lat.). The fifth Sunday after Lent was so called, because the service on that day began with the words of Psalm xliii. 'Judica me, Domine' ('Judge me, O Lord').

Judicium Dei (Lat. *judgment of God*). The term formerly applied to all extraordinary trials of secret crimes, as those by arms, single combat, ordeals, &c.; in which it was believed that Heaven would miraculously interfere to clear the innocent and confound the guilty.

[ORDEAL; QUESTION.] Full particulars of the ceremonies instituted on such occasions will be found in Ducange.

Juga (Lat. *yokes*). In Botany, the term applied to the ridges on the fruit of the *Umbelliferæ*.

Jugal Bone (Lat. jugum, or Gr. ζυγόν, *a yoke*). The cheek bone; so called because it has a *yoke-like* articulation to the temporal bone and the bone of the upper jaw.

Jugata (Lat. *yoked*). Two heads represented upon a medal side by side, or joining each other.

Juggernaut. [VISHNU.]

Jugglers (Fr. jongleurs). A general denomination for persons who practise the arts of legerdemain, or who exhibit feats of uncommon strength or dexterity. The reader will find in Beckmann's *History of Inventions* a learned and curious account of the origin and history of all feats of this kind exhibited both in ancient and modern times.

Juglandaceæ (Juglans, one of the genera). A small natural order of Exogenous trees of the Quernal alliance, distributed through the temperate parts of North America and Asia. The common walnut, *Juglans regia*, is well known for its agreeable fruit, and the useful oil which it yields by pressure. The wood of *Juglans nigra* and *regia* is valuable for cabinet-makers' work and similar purposes.

Juglandin (Lat. juglans, *a walnut*). An extractive matter contained in the green shell of the walnut; it becomes rapidly brown by exposure to air. It is used medicinally as an alterative, and also as a black hair-dye.

Jugular Veins (Lat. jugulum, *the throat*). The veins which bring the blood from the head, descending upon the sides of the neck; they are divided into *external* and *internal*. By their union with the subclavian veins they form the superior *vena cava*, which terminates in the superior part of the right auricle of the heart.

Jugulars. The name under which Linnæus comprehended all those fishes which have the ventral fins anterior to the pectorals.

Jugulum (Lat. *the throat*). In Mammalogy, this term is restricted to the forepart of the neck, which intervenes between the throat (gula) and the chest. The *fossa jugularis* is the hollow in front of the sternum at the base of the neck.

Jugum (Lat. *a yoke*). In Botany, a pair of leaflets. Thus, leaves which consist of only one such pair are described by the term *unijugus*; if of two pairs, by *bijugus*; and if of many pairs, by *multijugus*, and so on.

Jujube. The fruit of the *Zizyphus vulgaris*; it resembles a small plum, and is occasionally used as a sweetmeat. What is sold under the name of *jujube paste* professes to be the dried jelly of this fruit, but is in fact a mixture of gum arabic and sugar slightly coloured.

Julian The commencement of a period invented to correspond with the cycles of the Julian year. It coincides with the 710th year before the creation of the world, according to common chronology.

Julian Calendar. The civil calendar introduced at Rome by Julius Cæsar, and used by all the Christian countries of Europe till it was reformed by Pope Gregory XIII. in 1582. [CALENDAR.]

Julian Epoch. In Chronology, the epoch or commencement of the Julian Calendar. The first Julian year commenced with the 1st of January of the 46th year before the birth of Christ, and the 708th from the year assigned to the foundation of Rome.

Julian Period. In Chronology, a period consisting of 7980 Julian years. The number 7980 is formed by the continual multiplication of the three numbers 28, 19, and 15; that is, of the cycle of the sun, the cycle of the moon, and the cycle of indiction. The first year of the Christian era had 10 for its number in the cycle of the sun, 2 in the cycle of the moon, and 4 in the indiction. Now the only number less than 7980 which, on being divided successively by 28, 19, and 15, leaves the respective remainders 10, 2, and 4, is 4714. Hence the first year of the Christian era corresponded with the year 4714 of the Julian period; and hence also the year of our era corresponding to any other year of the period, or vice versâ, is found by the following rule:—

1. When the given year is anterior to the commencement of the era, subtract the number of the year of the Julian period from 4714, and the remainder is the year B.C.; or subtract the year B.C. from 4714, and the remainder is the corresponding year in the Julian period.

2. When the given year is after Christ, subtract 4713 from the year of the period, and the remainder is the year of the era; or add 4713 to the year in the era, and the sum is the corresponding year of the Julian period. (*Ency. Brit.* art. 'Chronology.')

Julian Year. The year adopted in the calendar of Julius Cæsar, and equal to $365\frac{1}{4}$ days. The Julian year exceeds the mean solar year, as determined by the best astronomical observations, by 11 minutes and 10·35 seconds, which amounts to a day in 129 years. In the course of a few centuries this error would become very perceptible, as the equinoxes and solstices would fall back towards the beginning of the year. When the Julian calendar was introduced by Cæsar, the vernal equinox fell on the 25th of March; at the time of the council of Nice, in 325, it fell on the 21st; and at the reformation of the calendar, in 1582, it had retrograded to the 11th. This observati n enabled Pope Gregory to fix the length of the year more precisely, and correct the intercalations. [CALENDAR.]

Julis (Lat.). A genus of Labroid fishes, distinguished by the following characters: Head smooth; cheeks and gill-covers without scales; lateral line bent suddenly downwards when opposite the end of the dorsal fin. The Rainbow Wrasse (*Julis mediterranea*) has been taken on the coast of Cornwall.

July (Lat. Julius; so named by Mark Antony, in honour of Caius Cæsar, the dictator, whose gentile name was Julius). July is at present the seventh month of the year. In the earlier Latin calendar it was the fifth, and hence was termed *Quintilis*. The Dog-days are supposed to commence on the 3rd of this month.

Jumping Hare. A Rodent quadruped, the largest of the family of the Jerboas (*Dipodidæ*), and the type of the genus *Helamys*, is so called. It is a native of the Cape of Good Hope, and inhabits deep burrows.

Juncaceæ (Juncus, one of the genera). A small obscure natural order of Endogenous plants of the Juncal alliance; in most respects resembling *Liliaceæ*, differing chiefly in their flowers being glumaceous, that is, thin, dry, and either brown or green in colour. There are, however, species intermediate between the two orders in this respect. None of the species are of any importance. The common rush is the usual type of the order. [JUNCUS.]

Juncaginaceæ (Juncago, an old synonym of one of the genera). A small natural order of Endogenous plants of the Alismal alliance, growing in ponds and marshes, with minute green flowers. They are allied to *Naiadaceæ*, differing in their hermaphrodite flowers. Some of them have a resemblance to rushes; others are floating plants; and some of them, as *Aponogeton*, are very handsome when in flower.

Junckerite. A native crystalline protocarbonate of iron from Poullaouen in Brittany.

Juncus (Lat.). The botanical name of the Rush. It is an extensive and widely distributed genus, of which some twenty species occur in this country. The pith forms the wick of the now almost exploded *rush-lights*; and the stems are made into mats.

June (Lat. Junius). At present the sixth month of the year, but in the old Latin calendar the fourth. It consisted originally of twenty-six days, to which Romulus is said to have added four. Numa, it is stated, deprived it of one day; which, however, was again restored by Julius Cæsar, and it has ever since remained unaltered.

Jungermanniaceæ (Jungermannia, one of the genera). A small natural group of Acrogenous or Cryptogamic plants, resembling mosses in appearance, and, like them, growing upon the bark of trees and in damp ground in shady places. They bear their seeds in cases containing spiral threads, which by their elasticity disperse the former when ripe. [HEPATICÆ.]

Juniper. The common name of *Juniperus*. The fruit of *Juniperus communis*, known as Juniper berries, is used in medicine as a diuretic; but is more largely employed in flavouring gin. When distilled with water, these berries yield an essential oil, upon which their pecular flavour depends. Sandarach, a resinous substance occasionally used in varnishes, has been said to come from the Juniper, but on good authority it is now referred to *Callitris*. When powdered it is used under the name of *pounce*, to prevent ink sinking into paper from which writing has been erased.

Junk (Dutch jonk, perhaps from Chinese yong, *the sea*). The name given to a kind of ship built by the Chinese, Japanese, and Malays. Cumbrous in shape, it is incapable of great speed; but these nations are good sailors, and venture on long ocean voyages in their junks with impunity.

JUNK. The name given by sailors to salt beef as supplied at sea, which by hard salting and long keeping becomes as hard as small pieces of old rope called *junks*, a word employed officially and perhaps allied to Lat. juncus, *a rush*.

Junk Ring. A metallic packing, confining the hemp packing of a piston, and capable of being screwed down upon it.

Junk Wads. In Artillery, these wads are made of oakum bound round with spun yarn, and are of similar diameter to the bore of the gun for which they are intended. They are used in firing hot shot, and also occasionally with bronze ordnance, to prevent indentation of the bore near the seat of the shot. In both cases they are placed between the charge and the projectile.

Juno. The Latin name of the divinity called by the Greeks HERA [which see]. She was the sister and consort of Jupiter, and was held to preside over marriage, and protect married women. The name Juno, Junonis, would answer to a Greek form Zênon, as Janus answers to the Sanscrit Dyavan. (Max Müller, *Lectures on Language*, second series, p. 452.)

JUNO. In Astronomy, one of the four small extra-zodiacal planets which circulate between the orbits of Mars and Jupiter. Juno was discovered by Prof. Harding, of Lilienthal (near Bremen), on September 22, 1804; Ceres and Pallas having been discovered previously. Juno shines as a star of the eighth or ninth magnitude, and is of a whitish colour without nebulosity. This planet at the time of its discovery was considered remarkable on account of the great eccentricity of its orbit, exceeding that of any other then known planet, and amounting to ·2578, the semi-axis major being taken as unity. The effect of this eccentricity on the motion of the planet is such, that the half of the orbit which is bisected by the perihelion is described in about half the time in which the other half is described. The sidereal revolution is performed in 1592·66 mean solar days. The inclination of the orbit to the ecliptic is 13° 1′ 20″. The extreme smallness of the planet renders it impossible to determine its apparent diameter, and consequently its magnitude, with any degree of certainty.

Junta (Span. *an assembly*). A grand Spanish council of state. Besides the assembly of the states or *cortes*, there were two juntas: one which presided over commerce, the mint, and the mines; and the other forming a board for regulating the tobacco monopoly. In England the term *junto* (evidently of Spanish origin) has been used almost synonymously with cabal or faction.

Jupiter (Lat.). In Astronomy, one of the planets, and the largest in the system. The diameter of Jupiter is no less than 89,000 miles, or about eleven times that of the earth; consequently, his bulk is about 1,500 times greater than that of the earth. The mean distance of Jupiter from the sun is upwards of 495 millions of miles, or about $5\frac{1}{4}$ times the radius of the earth's orbit; and he performs his revolution in respect of the stars in 4,332 d. 14 h. 2 m. $8\frac{1}{2}$ s., which is nearly 12 years. The inclination of the orbit to the plane of the ecliptic was $1^\circ\ 18'\ 51''$ at the beginning of the present century, and undergoes a diminution of about a fourth of a second in a year. The inclination of the planet's axis to the ecliptic is but $3^\circ\ 5'\ 30''$, so that the planet can scarcely be said to have any seasons.

The disc of Jupiter is observed to be crossed generally in one direction by dark bands or belts. These belts are, however, by no means alike at all times; they vary in breadth and in situation on the disc (though rarely in their general direction). They have even been seen broken up, and distributed over the whole face of the planet, and as many as forty have been seen at once; but this phenomenon is rare. Branches running out from them, and subdivisions, as well as evident dark spots, like strings of clouds, are by no means uncommon; and from these, attentively watched, it is concluded that the planet revolves in the surprisingly short period of 9 h. 55 m. 50 sec. (sid. time) on its axis, to which the direction of the belts is perpendicular.

The parallelism of the belts to the equator of Jupiter, their occasional variations, and the appearances of spots seen upon them, render it extremely probable that they subsist in the atmosphere of the planet, forming tracts of comparatively clear sky, determined by currents analogous to our trade winds, but of a much more steady and decided character, as might indeed be expected from the immense velocity of its rotation. That it is the comparatively darker body of the planet which appears in the belts is evident from this—that they do not come up in all their strength to the edge of the disc, but fade gradually away before they reach it. (Herschel's 'Astronomy,' *Cabinet Cyclopædia*, p. 281.)

The radius of Jupiter being eleven times greater than that of the earth, and the rotation on the axis being 2·4 times more rapid, the space passed over by a point on the equator of the planet will be twenty-six times greater than that described by a point of the terrestrial equator in the same time. Hence the centrifugal force is about twenty-six times greater, and we might therefore conclude that its effect in impressing a flattened form on the planet will be much greater than that observed with regard to the earth. Now observation shows this to be the case. The disc of Jupiter is evidently not circular, but elliptic, being considerably flattened in the direction of its axis of rotation; and this appearance is no optical illusion, but is authenticated by micrometrical measures, which assign 15 to 14 as the proportion of the equatorial and polar diameters. This far exceeds the compression of the earth, the ratio of the equatorial to the polar diameter of which is 302 to 301.

The density of Jupiter is very nearly the same as that of the sun, and about one-fourth of the mean density of the earth. The mass of the planet compared with that of the sun taken as unity, is ·000943; but this is sufficient to produce a very sensible perturbation of the motions of some of the other planets. The proportion of light and heat received by Jupiter from the sun, compared with that received by the earth, is as ·037 to 1.

Jupiter, through the telescope, is observed to be accompanied by four moons or satellites, which revolve about the planet nearly in the plane of its equator, exactly in the same manner as the moon revolves about the earth. Their configuration changes at every instant; they appear to oscillate on each side of the planet, and their rank or order of distance is determined by the extent of their oscillations. In coming between the sun and Jupiter, the satellites throw their shadows on the planet, and produce eclipses of the sun; and when they come to the side of the planet opposite to the sun, they are eclipsed in passing through the shadow. The beginnings and endings of these eclipses can be observed with great precision; and their observation furnishes the surest means of determining the sidereal and synodic revolutions of the satellites. The same observations also afford a means of determining terrestrial longitudes; and it was by means of them that astronomers discovered and measured the velocity of light. [PLANET and SATELLITE.]

JUPITER. In Mythology, the Latin name of the deity called by the Greeks ZEUS [which see].

Jurassic Rocks. The limestones and other deposits of the Jura belonging to the middle secondary period offer the nearest analogues to the typical oolitic series of England, and thus the part of the geological sequence called by us *oolitic* (from the prevalence of a particular variety of limestone) is there designated *Jurassic*, the ooli

large part of the Alpine chain consists of rocks of the Jurassic period; and the deposits, owing to the great amount of mechanical disturbance and chemical action to which they have been subjected, offer singular varieties of condition. They include crystalline limestones and marbles, quartzites, and highly metamorphosed slates and schists. The fossiliferous portions, however, admit of comparison with those of England, the subdivisions being strongly marked, especially in the upper series. Thus, the upper Jurassic beds are limestones and clays, like the Portland rock and Kimeridge clay. The middle and lower series are marked by less perfect subdivisions than in England.

Jurinite. A mineral from Dauphiny, containing *titanium*.

Jurisconsult (Lat. juris consultus, *learned or skilled in law*). A title given to a class of Roman lawyers, and commonly denoted by the abbreviation *ictus*. From what we know of the jurisconsults, they appear to have been a different class from the advocati or causidici, who conducted causes, and to have confined themselves to the employment of giving responsa or opinions on cases put to them. (*Mém. de l'Acad. des Inscr.* vol. xli.) From the recorded opinions of the most learned jurisconsults, the *Digest*, the great work of Justinian, was chiefly compiled. [ADVOCATE.]

Jurisprudence (from the Latin words juris prudens, *skilled in law*). The science of law. The term *civil jurisprudence* is sometimes restricted to the science of the Roman or civil law. For a complete list of works on this extensive subject, down to comparatively recent times, see Krug' *Phil. Lex.* art. 'Rechtslehre.'

Jury, Trial by. Of the origin and progress of this institution, as far as it has been very imperfectly traced by antiquarians, some account has been given in the historical review of the Common Law. (Forsyth, *History of Trial by Jury*, 1852.) When issue has been taken in fact in a civil suit [PLEADING], the cause stands ready for trial *at bar* of the court itself [LAW; COURTS, SUPERIOR], unless by the fiction of NISI PRIUS it is transferred to the sittings in London and Middlesex, or the assizes in the country. (A trial at bar is now only granted on application in some special cases.) The sheriff of the county is directed by a precept issued by the judges of assize to summon jurors to attend at the assizes. A similar process issues to summon jurors for the sittings in London or Middlesex. The plaintiff and defendant are alike entitled to have the cause tried by a *special jury*. The list of persons liable to serve as common jurors is made out by the churchwardens and overseers in each parish, and after being considered by justices at petty sessions, is copied into a book and delivered to the sheriff. In obedience to the *precept* for summoning jurors, the sheriff returns a panel or list of persons taken from this book, in number from 48 to 72, and the same panel now tries all issues, whether criminal or civil, at the session for which it is made out. The twelve jurors who are to try the cause are chosen by ballot out of this list. The qualification of a common juror is, to be a natural-born subject (unless on trial of an alien, in which the accused may if he pleases have a jury *de medietate linguæ*, of which one half consists of aliens), to be free from attaint of an infamous crime, and to be between the ages of twenty-one and sixty. All such persons (with certain privileged exceptions) possessing 10*l.* a year in freehold or copyhold lands and tenements, or 20*l.* a year in lands held on lease for twenty-one years, or rated as householders to the poor's rate in Middlesex for 30*l.*, elsewhere 20*l.*, or occupying a house with fifteen windows, are liable to serve. In the city of London the juror must be a householder or occupier within the city, and have property, real or personal, to the amount of 100*l.* All persons described in the jurors' book as esquires or of a higher degree, or as bankers or merchants, are qualified to serve on special juries. If on a trial sufficient qualified jurors are not in attendance, a *tales* may be prayed; and bystanders are called in to fill up the number. This seldom occurs but in special jury cases; and in these the *talesmen*, as they are vulgarly termed, are taken from the common jury list.

The jury being summoned, the trial proceeds; unless either party *challenge* the jurors. *Challenges* are either *to the array* or *to the polls*. A challenge to the array is an objection to the whole panel, and can only be on account of default or partiality of the sheriff. Challenges to the polls, i. e. to individual jurors, are said to be of four kinds; *propter honoris respectum*, *propter defectum*, *propter affectum*, and *propter delictum*. 1. Where a party is exempted by statute from serving, he may challenge himself. 2. Insufficient qualification is a ground of challenge by either party. 3. On supposed bias or partiality, as by reason of kindred. Challenges to the favour are on a mere suspicion of partiality. 4. Legal infamy is the fourth ground of challenge. In a criminal case the law of challenges is the same as in a civil one; except that the prisoner for felony has the additional privilege of making *peremptory* challenges without cause assigned to any number of jurors not exceeding twenty. Challenges for cause, if *to the polls*, are tried by the court; except those to the favour, which the court appoints two jurors if sworn, if not two indifferent persons, to try. Challenges to the array are tried entirely at the discretion of the court.

According to the common course of a trial at nisi prius, the counsel for that party on which the affirmative of the issue is thrown by the pleadings (that is, except in occasional cases, the plaintiff) *opens his case* by a statement to the jury, and then calls witnesses to prove it. He may now, since 17 & 18 Vict. c. 125, also sum up his case at the end, unless the opposite counsel says he is about to call witnesses. The counsel for the other party then replies; and if he also calls witnesses, he likewise may sum up, and the first speaker has a final reply. After the evidence is given and the case closed, the jurors are kept together to deliberate on their verdict. They must be without meat, drink, or fire, unless otherwise ordered by the judge; and as unanimity is necessary to a verdict, it was held at common law that if the jury could not agree, the judge might cause them to be carried round the circuit from town to town in a cart. In practice, it is usual, when they cannot be brought to agreement, to discharge the jury. Although the jury in ordinary language are said to be judges of the *fact* only, yet a general verdict in a civil or criminal case ordinarily decides both the facts, and whether the law as stated by the judge is immediately applicable to those facts e. g. a verdict *guilty*

on a charge of murder implies both that the act was committed, and that it was committed under circumstances amounting to murder. The jury may, however, find under certain circumstances a *special* verdict, that is a verdict in which the facts of the case are specially stated, and it is left to the court to apply the law; or they may find a general verdict, subject to a special case as to a point of law. In cases of criminal prosecution for libel, much difference of opinion formerly prevailed as to the effect of a verdict. It was held by most lawyers that the only questions for their consideration were the fact of publication, and the truth of what is technically called *the innuendos*, viz. that the passages of the libel cited did apply to such or such facts and individuals. But by 32 Geo. III. c. 60 (passed through the influence of Mr. Fox) it was enacted that on every trial of an indictment or information for libel the jury may find a general verdict of guilty or not guilty upon the whole matter in issue, thus deciding whether the matter published amounts to a libel or no. As to the grand jury, see INDICTMENT.

Trial by jury, essentially an English institution, has only gradually and imperfectly made its way into the institutions of foreign countries; but its excellence for the purposes of criminal justice seems to be now generally admitted, whatever opinions may be entertained respecting its value in civil cases.

In Scotland, there is some question as to the antiquity of trial by jury in civil cases. But the practice, if ever it existed, became early obsolete; and it was reintroduced in 1815 by the Act 55 Geo. III. c. 42. The verdict of nine (out of twelve) jurors may now be taken after three hours' deliberation. In criminal cases, trials have taken place, immemorially, by an *assize* or jury of fifteen. The verdict is that of a majority, and may be either guilty, not guilty, or *not proven*; in which last case the party cannot be tried a second time.

In America, trial by jury in criminal cases, and in civil above twenty dollars, is established by the constitution of the United States. It is regulated for most purposes by the law of the several states: the general rule is that of unanimity.

Trial by jury in criminal cases was first established in France in 1791. The *jury of accusation*, analogous to the English grand jury, was then established, but shortly discontinued: the *jury of judgment* alone subsists. The jury decide, by a majority, on the question of guilty or not guilty, and subsequently whether there are *extenuating circumstances*. There is no trial by jury in civil cases; though in certain cases special bodies so termed may be called to assess damages, as in the case of compensation for *expropriation*.

Trial by jury exists in criminal cases in Belgium, Portugal (majority of two-thirds), Switzerland, and Italy. It was introduced into Prussia in 1849 (majority; but if seven to five, the judges decide); and into Austria in 1850.

Jury-mast. In Naval affairs, a temporary mast erected in a ship in the room of one that has been carried away. Jury-masts are sometimes erected in a new ship to navigate her down a river, or to a neighbouring port, where her proper masts are prepared for her.

Jus (Lat. *an ordinance* of human law, as contrasted with fas, the obligation of divine law). According to Gaius, all law was divided into jus gentium, the law of nations, and jus civile, or the whole body of law peculiar to any state. Ulpian and other lawyers added a third distinction, namely jus naturale, or a law common to man and beasts. The civil law was comprehended in the jus scriptum and jus non scriptum, or written and unwritten law, and was divided into *public* and *private* law.

The word *jus* also had the meaning of a faculty or legal right. Thus we have the jus connubii, or right of intermarriage, a right strictly guarded in all ancient states; jus quiritium, or the state of full Roman citizenship; jus imaginum, the right of setting up busts or images of forefathers, answering to our right of using armorial bearings, &c. Modern law has introduced many other distinctions under the head *jus*, which our limits forbid us to notice. (See the article 'Jus,' and the other articles to which reference is therein made, in Dr. Smith's *Dictionary of Greek and Roman Antiquities.*)

Juste Milieu. [MILIEU, JUSTE.]

Justices of the Peace. In English Law, these magistrates are descended from the ancient conservators of the peace, and are appointed to their office in every county by the king's special commission under the great seal; which appoints them all, jointly and separately, to keep the peace, and any two or more of them to enquire of or determine felonies and misdemeanours. Some justices, also, are so by Act of Parliament or charter, as the mayor and other magistrates in corporate towns, &c., and certain other particular officers. Some justices are expressly nominated in the commission, so that certain business cannot be transacted without their presence; these are said to be of the *quorum*, and all the justices are now usually included in the list. The qualification of a justice is to have an estate of 100*l.* a year free of incumbrance, or a reversion after one or more lives of 300*l.* a year; but many privileged persons may act without qualification by estate. A justice intending to act under this commission sues out a writ of *dedimus potestatem* from the clerk of the crown in chancery, and takes certain usual oaths.

The duties and powers of a justice of the peace are of two kinds; ministerial and judicial. 1. He acts in the former capacity in preserving the peace; hearing charges against offenders; examining the informant and his witnesses; binding over the parties to prosecute or give evidence; and committing, or admitting to bail, according to the nature of the offence, parties who are brought before him. The stat. 11 & 12 Vict. c. 42 requires justices to take the

most material part of the evidence on examinations before them in writing, to be returned to the assizes, both in charges of felony and misdemeanour. 2. An extensive jurisdiction, summary and formal, is now exercised by justices of the peace, numerous branches of judicature, both criminal and civil, having been gradually confided to their authority, either exercised by them individually, or at the petty sessions and general quarter sessions of the peace. The latter court, by 34 Edw. III., has jurisdiction over all felonies and trespasses whatever: in practice, simple larcenies and many other felonies and small misdemeanours are tried by a jury before it. But doubts having prevailed as to the extent of its authority, that authority in criminal cases was strictly defined in 1842 (5 & 6 Vict. c. 38); capital crimes, and also a variety of offences of the more serious class, being excepted from its jurisdiction. It has also by various statutes jurisdiction over several offences relating to highways and to game; it is an appellate court from many decisions of individual magistrates; and it has one large and exclusive power committed to its care by the legislature, viz. the hearing and deciding appeals from orders of magistrates relative to the imposition of the poor's rate, and to the removal of paupers from one parish to another in which they are shown to have a legal settlement. [SETTLEMENT.] Justices have, either singly or jointly, summary jurisdiction in questions of contract between certain classes of masters and servants; in small illegal takings of property, whether strictly personal, or in part connected with the freehold, not exceeding 5*s.* in value; and in common assaults and batteries not accompanied by an attempt to commit felony (stat. 24 & 25 Vict. c. 100) and in many other cases. The proceedings are in general on a written charge, sometimes termed a *complaint*; but in proceedings for a penalty more generally an information: on receiving which the justice grants a summons to cause the appearance of the party charged. An appeal to the quarter sessions from the conviction or order of justices is now in most cases expressly given by statute; and the court of session, on hearing the case, is said either to *affirm* or *quash* the conviction or order. The proceedings are further removable in some cases into the superior courts by certiorari, or by stating a special case.

Other summary remedies afforded by magistrates are in cases of forcible entry and detainer, and some that arise between landlord and tenant.

Justices of the peace are liable to actions at the suit of parties injured by them wilfully in the exercise of their authority. But it is provided by statute that they shall have notice of any action commenced against them, and the cause of such action, one month before the writ is sued out; and the action must be commenced within six months after the injury complained of. Persons recovering a verdict against a justice are now no longer (as formerly) entitled to double costs. These magistrates are also punishable criminally by indictment or information.

The police justices of London and its vicinity are stipendiary magistrates, created by Act of Parliament.

Justiciary, Chief (Low Lat. magnus justiciarius, or capitalis justiciarius totius Angliæ). An officer of high power and dignity under the Norman kings of England, who presided over all functio..ries in the aula regia, or king's court, so long as it followed the person of th king; and was, says Blackstone, by virtue of his office, guardian of the realm in the king's absence. The formidable power of the chief justiciary was curbed to some extent by the provisions of the great charter, especially that which fixed the trial of common pleas at Westminster; and became altogether obsolete when the various branches of his jurisdiction were broken into distinct courts of judicatur under Edward I. (Blackstone, *Com.* iii. 39.)

Justiciary, The High Court of, i Scotland. This court is composed of five of th Lords of Session, added to the Justice-Clerk, th president of the court. It is the supreme cour of criminal justice; with the power of advo cating or suspending all sentences of inferio criminal judges. It has circuit courts twic a year; and an additional circuit is now hel in Glasgow during the Christmas recess of the court of session. The sinecure office of Lord Justice-General was in 1831 merged in that of the Lord President. [SESSION, COURT OF.]

Justicies. In Law, a special writ empowering the sheriff of a county to hold plea of an action in his court. By means of this writ all personal and many real actions might be tried in the county courts. It is now disused.

Justification (Lat. justificatio, answering to the Gr. δικαίωσις). In Theology, men are said to be justified when accounted just or righteous in the sight of God, or placed in a state of salvation. According to the eleventh article of the church of England, we are justified 'by faith, and not for our works or deservings.' The twelfth declares, that, 'although good works, which are the fruits of faith, and follow after justification, cannot put away our sins and endure the severity of God's judgment, yet are they pleasing and acceptable to God in Christ, and spring necessarily out of a true and lively faith, insomuch that by them a lively faith may be as evidently known as a tree is discerned by the fruit.' The first of these articles is chiefly directed against the Romanist doctrine of meritorious works; the second, based on the language of St. James, that a 'man is justified by works, and not by faith only' (ii. 24), regards faith and works as inseparably connected, and is aimed principally against the doctrine of those who were termed Antinomians or Solifidians.

Justinian, Code of. [PANDECTS.]

Jute. The fibre of *Corchorus capsularis* and *C. olitorius*, much used in India for making cordage and coarse cloths.

K

K. A consonant, used in most ancient and modern languages. It is derived from the Greek *kappa*, the Hebrew *koph*. It has the same sound as C before *a*, *o*, and *u*, and hence it has often been pronounced superfluous. In Latin K occurs only in a few words, though it was frequently used in the same language as an abbreviation for words beginning with C; as K.T. for capite tonsus, &c. &c. In the French alphabet K is only used in words derived from foreign languages. As a numeral it was employed to express 250—

K quoque ducentos et quinquaginta docebit.

Kaaba. [CAABA.]

Kabbala. [CABALA.]

Kadi. [CADI.]

Kaimacan or **Caimacan.** A title given in the Ottoman Empire to a deputy or governor. There are generally two kaimacans, one residing at Constantinople, the other attending the grand vizier as his lieutenant.

Kainozoic. [CÆNOZOIC.]

Kakodyle (Gr. κακός, *bad*, and ὕλη, *matter*). A compound of hydrocarbon and arsenic, having the formula $C_4 H_6 As$. It is a clear liquid, which takes fire when dropped through the air, burning with a blue flame, and forming water, carbonic acid, and arsenious acid; the latter rises as a white smoke. *Cadet's fuming liquor*, called also *Alkarsine*, is an oxide of kakodyle $= C_4 H_6 As O$.

Kakodylic Acid. *Alcargen*, or *cacodylic acid.* A product of the oxidation of kakodyle.

Kakoxene or **Cacoxene** (Gr. κακός, *bad*, and ξένος, *guest*). A native phosphate of iron, occasionally associated with the native oxides. So called, probably, in consequence of the injurious effect produced by the phosphorus which it contains, upon the iron smelted from the ore with which it is found.

Kalamaika. The name of a favourite Hungarian dance.

Kale, Sea. [CRAMBE.]

Kaleidophone (Gr. καλός, *pretty*; εἶδος, *form*; and φωνή, *sound*). An invention of Prof. Wheatstone's, in which a knob reflecting a point of light attached to a vibrating plate describes various beautiful curves corresponding with the musical notes produced by the vibrations.

Kaleidoscope (Gr. καλός; εἶδος; and σκοπέω, *I view*). An optical toy, which, by a particular arrangement of reflecting surfaces, presents to the eye a series of symmetrical images often remarkable for their beauty.

The kaleidoscope is formed by two plane mirrors or slips of glass, from six to ten inches in length, and from an inch to an inch and a half in breadth at the one end, though somewhat narrower at the other, joined together along the edges lengthwise, and inclined to each other at an angle, which must be an even aliquot part (that is to say, the sixth, eighth, tenth, &c.) of four right angles. The edges of the mirrors are kept in contact by a strip of black silk glued along the back of the plates, which, if formed of glass, must be coated with black varnish or sealing wax, to prevent reflexion from their posterior surfaces. The mirrors being adjusted at the proper angle, are placed within a tin tube, where they are kept in their proper position by pieces of cork or wood wedged in between them and the tube. One end of the tube has a small circular aperture in its centre, to which the eye is applied; in the other end two plane glasses are fixed parallel to each other, and perpendicular to the axis of the tube, and about an eighth of an inch apart. Between these glasses, which form a cell, the objects which produce the images are placed. Those which answer the purpose best are small fragments of coloured glass, beads, or other coloured diaphanous matters, of such a size that when the tube is turned round they move freely within the cell and assume new positions. In order that the eye may not be disturbed by objects without the tube, the outer glass should be slightly ground, but the inner must be perfectly transparent.

On applying the eye to the aperture of the tube, the objects within the cell at the other end are seen multiplied by repeated reflections from the two mirrors, and a succession of symmetrical images presented, all arranged round a centre, and combined into a perfect whole. As the objects are placed loosely in the cell, every motion of the tube changes their relative positions, and produces an entirely new image; and it is this endless variety of new combinations which creates the pleasing effect.

Kalends. [CALENDS.]

Kali. An Arabic word, signifying the ashes left after the combustion of vegetable substances; hence the word *alkali*. Potassa is frequently termed *kali*, and potassium *kalium*, by the German chemists; hence K is used as the symbol for potassium.

Kalmia (from Kalm, a traveller in North America). A genus of beautiful North American Ericaceous plants, with a monopetalous corolla, which confines ten stamens by their anthers in the same number of niches in its sides. The flowers are white or pink, and the leaves evergreen; but the plants are noxious, and *K. angustifolia* has received the name of Lambkill. The Canadian partridge is said to become poisonous as human food after feeding on the *Kalmia*.

Kalyptolite. [CALYPTOLITE.]

Kami. A Japanese title belonging primarily to the celestial gods who formed their first mythical dynasty, then extended to the terrestrial gods

of the second dynasty, and then to the long line of spiritual princes who are still represented by the micado. [TYCOON.] In addition to this, every patriot, or anyone distinguished for saintliness or miraculous powers, may after death be deified as a kami, so that the number of these demigods is indefinite. Some of these spirits preside specially over the elements and powers of nature. The worship of these demigods is called Kami-no-mitsi, or the Way of the Kami. (Bishop of Victoria's *Ten Weeks in Japan*, p. 44; Klaproth, *Annals of Japan*, 1834.)

Kamichi. The name of a Rasorial or Gallinaceous bird, remarkable for having its wings armed with two strong spurs, and its head with a long, slender, cylindrical and nearly straight horn. [PALAMEDEA.]

Kammererite. A hydrated silicate of alumina and magnesia, often accompanying chromite of iron. Named after Kammerer, the mineralogist.

Kamptulicon. A name given to a new variety of floor covering, composed of Indian rubber, gutta percha, and cork. Equal quantities of the two former substances, having been first liquefied in naphtha or some other proper solvent, are mixed with cork which has been ground into a fine dust. This mixture, while warm and soft, is flattened out, by being passed under smooth heavy rollers, into sheets ten or twelve yards long, varying in width from one to two yards, and from one-eighth of an inch to one inch in thickness. The sheets thus prepared are allowed to lie flat until sufficiently set or hardened, when they are rolled up as fit for use. Patterns are printed on the material thus prepared, in the same way in which floor cloth is stamped by blocks.

The advantages of kamptulicon over ordinary floor cloth consist in its warmth, softness, and elasticity, and if the whole floor is covered it is perhaps more durable; but on the other hand it is easily torn, and when once laid upon a floor it cannot be removed without considerable damage.

Kampylite (Gr. καμπύλος, *curved*; from its barrel-shaped crystals). A variety of Mimetite which is found crystallised, of colours varying from yellowish to brown and brownish-red, at Drygill in Cumberland; also at Badenweiler and Johanngeorgenstadt in Saxony.

Kamsin. A hot dry southerly wind, common in Egypt and the deserts of Africa. It blows sometimes for fifty days together.

Kaneite. Native arsenical manganese, named after Sir R. J. Kane, by whom it was first noticed.

Kangaroo. The native name of a large indigenous quadruped of New Holland; it belongs to a genus characterised by a strictly herbivorous modification of the marsupial type of the dental organs, and by a remarkably long and strong tail and hind legs. [MACROPUS and MARSUPIALIA.]

Kantian Philosophy (known also by the name of the Critical Philosophy). A system of philosophy, which owes its existence to Immanuel Kant, professor of logic and metaphysics in the university of Königsberg in the latter half of the eighteenth century. The promulgation of Kant's doctrines forms a very marked era in the history of philosophy.

At the time when Kant commenced his metaphysical labours, the philosophical world was divided between the sensualism of the French followers of Locke on the one hand, and the dogmatic rationalism of the disciples of Wolf and Leibnitz on the other. The former, by a species of analytical legerdemain, resolved all our mental powers into modifications of sense; while the latter, in an equally indiscriminating spirit, though with far more laudable intentions, sought to construct a system of real truth out of the abstract conceptions of the understanding. Against both of these schools Kant declared open warfare. Withdrawing himself from all ontological speculation, he sought, by a stricter analysis of our intellectual powers, to ascertain the possibility and to determine the limits of human knowledge. He divides the speculative part of our nature into three great provinces—sense, understanding, and reason. Our perception of the outward world is representative merely: of things as they are in themselves it affords us no notice. In order to render human experience possible, two ground-forms, under which all sensible things are contemplated, are assumed—time and space. To these he assigns a strictly subjective reality. The truth of the fundamental axioms of geometry rests on the necessity and universality of our intuitions of space in its three dimensions—intuitions which are not derived from any one of our senses, or from any combinations of them, but lie at the ground and are the condition of all sensible human experience. The understanding, or the faculty which combines and classifies the materials yielded by sense, Kant subjects to a similar analysis. All its operations are generalised into four fundamental modes or forms of conception; which, after the example of Aristotle, he names *categories*. [CATEGORY.] These are four in number: 1. Quantity, including unity, multeity, totality; 2. Quality, divided into reality, negation, and limitation; 3. Relation, viz. substance and accident, cause and effect, action and reaction; and 4. Modality, also subdivided into possibility, existence, and necessity. These form, as it were, the moulds in which the rude material of the senses is shaped into conceptions, and becomes knowledge properly so called. The categories in themselves are the subject-matter of logic, which is thus far a pure science, determinable à priori. The third and highest faculty, the reason, consists in the power of forming ideas—pure forms of intelligence, to which the sensible world has no adequate correspondents. Out of these ideas no science can be formed; they are to be regarded as regulative only, not as constitutive. The existence of God, immortality, freedom, are the objects after which the reason is

perpetually striving, but concerning which it can decide nothing either one way or the other. Thus far Kant's system may be regarded as one of pure scepticism. The deficiencies of our speculative reason he conceives to be supplied by the moral faculty, to which he has given the name of *practical reason*, the object of which is to determine, not what is, but what ought to be. As the former determines the *form* of our *knowledge*, so the latter prescribes the form of our *action*. Obligation is not a mere feeling; it is a pure form under which the reason is compelled to regard human conduct. The personality of man, which lies at the ground of speculative knowledge, becomes in relation to action freedom of the will. It is in our moral nature that we must seek for the only valid foundation of the belief in God, the immortality of the soul, and a future state in which the demands of the practical reason shall be realised. (Kant's *Philosophical Works*; *Kritik der Reinen Vernunft*; *Kritik der Practischen Vernunft*; Masson's *Recent British Philosophy*; &c.)

Kaolin. The Chinese name for *porcelain clay*. A large tract of this useful substance occurs near St. Austell, in Cornwall, whence our potteries and porcelain manufactories are copiously supplied. The kaolin of Cornwall, and probably of other countries, is derived from the decomposition of the Felspar of granitic rocks.

Kapnite (Gr. *καπνός*, *smoke*). A variety of Calamine containing more than 15 per cent. of protoxide of iron, and found at Altenberg, near Aix-la-Chapelle.

Kara. A Tartar word, signifying *black*, used in many of the Eastern languages as a prefix to geographical names; as Karamania, *the country of the black people*. It has also been employed in the same capacity to signify *tributary*; as kara kalpacks, *tributary kalpacks*.

Karaites. [CARAITES.]

Karelinite. An oxysulphide of bismuth found in lumps of a lead-grey colour at the Sawodinsk mine in the Altai, accompanied by Telluric Silver. Named after M. Karelin.

Karmathians or **Karmatians.** A Mohammedan sect which arose in Irak during the ninth century of the Christian era. It derived its name from Karmata, its founder, a poor labourer, who assumed the rank of a prophet. They maintained bloody wars with the caliphs for nearly a century. (Taylor, *History of Mohammedanism*, p. 223; *Secret Societies of the Middle Ages*, Lib. Ent. Kn. 1837.)

Karpholite. [CARPHOLITE.]

Karphosiderite or **Carphosiderite** (Gr. *κάρφος*, *a chip* or *stalk*, and *σίδηρος*, *iron*). A straw-coloured phosphate of iron from Labrador.

Karstenite. A mineralogical synonym of *Anhydrite*, or anhydrous sulphate of lime, after the German chemist, Karsten.

Kât. The native name of the Arabian *Catha edulis*, from which is prepared a beverage having effects similar to those of tea. Recent investigations, however, seem to show that its stimulating powers are not owing to the presence of theine, none having been detected in it.

Kathetometer or **Cathetometer.** An instrument for measuring differences in height, as, for instance, between two liquid columns in equilibrium. It usually consists of a small telescope, sliding vertically upon an upright scale. The telescope is furnished with cross-wires, and the point of intersection of the latter being brought to coincide with the apex of one of the columns of liquid, the position of the telescope upon the scale is read off. The telescope is then directed to the other liquid column, and the point of intersection of the wires being again brought to coincide with the apex of the column, a second reading is made. The difference between the two readings expresses the difference in vertical height between the two columns.

Kava or **Kawa.** Vernacular names for the Ava, *Macropiper methysticum*, a kind of pepper, with narcotic stimulant properties; it is chewed by the Polynesians much in the same way as the Betel Pepper.

Keckling (akin to the German kugeln, *to roll*; Dan. kekkil). A Sea term denoting the act of encircling a cable or hawser with old rope or small chain to prevent it chafing at the hawsehole as the ship rides at anchor, or to avoid the dangerous rubbing of ice or sunken rocks.

Kedge, Kedge Anchor, Kedger (Dan. keddsch). A small anchor borne by large ships, and employed in shallow water to keep the ship's bow clear of the main anchor. It is also employed in moving from one mooring to another; a boat conveys the kedge, and drops it at the length of the cable or point desired, when the vessel is hauled up to it.

Keel (Icelandic, kiolr; Dutch, kiel). The principal piece of timber in a ship, first laid on the blocks in building. If we compare the body of a ship to the human skeleton, the keel seems to resemble the backbone, and the timbers the ribs. It is generally composed of several thick pieces of wood placed lengthways, which after being scarfed together are bolted and clenched through the floor timbers. From the keel rise at its extremities the stem and stern post. Serious damage to the keel involves the destruction of the ship; great care is therefore taken to protect it, by fastening, somewhat loosely, below it a *false keel*, which, if the vessel takes the ground, will probably come off and leave the true keel unharmed. The word seems originally to have signified an entire ship; for we read that the Saxons invaded England in caels (or keels), and in early times a fleet was described as so many keels. This signification partly lives in *keelage*, which is a duty levied on vessels entering certain ports.

KEEL. In Botany, a name applied in a figurative sense to the two lowest petals of a Papilionaceous corolla, which, together, have some resemblance to the keel of a boat.

Keel Hauling. An obsolete punishment practised chiefly in the Dutch navy, by which

the culprit was let down on one side of the ship, and after passing under the keel was *hauled* up on the other. This punishment was formerly not altogether unknown in the British navy; but it is now never resorted to.

Keeling. A name for the common cod (*Morrhua vulgaris*, Cuv.). [MORRHUA and GADUS.]

Keelson. In Shipbuilding, an inner keel passing throughout the vessel's length parallel to the keel; but above the floor-timbers, through which it is bolted to the keel. It adds greatly, or rather is indispensable, to the stability of a wooden ship. The heels of the masts rest upon the keelson. *Sister keelsons* are smaller keelsons situated on each side of the keelson at a short distance for the purpose of consolidating the floor-timbers, crosspieces, and futtocks. Like the keel, the keelsons are composed of several pieces of timber scarfed together and secured by dowels or coaks. [KEEL.]

Keep (A.-Sax. kepan). A word denoting the stronghold of a castle, to which in cases of emergency the besieged inmates retreated, and there made their last efforts of defence. [DONJON.]

Keeper of the Great Seal, Lord, or **Lord Keeper.** An officer of high dignity in the English constitution, whose office is created by the delivery of the king's great seal into his custody. He is prolocutor or speaker of the House of Lords by prescription. By 5 Eliz. c. 18, the offices of lord chancellor and lord keeper are declared to be of exactly the same authority; and when there is no chancellor, the great seal is ordinarily put in commission. [CHANCELLOR; SEAL.] (Bl. *Com.* iii. 47.) The keeper of the privy seal is styled Lord Privy Seal.

Keeper of a Magnet. [MAGNET.]

Keeping. In Painting, the management of the lights, shadows, colours, and aërial tints in such subordination to each other that each object may seem to stand rightly in the place which the linear perspective has assigned to it. Objects in the nearer parts or foreground of a picture will necessarily receive the strongest lights and shadows; and as more air is interposed in nature between the eye and the objects as they become more distant, so in the representations of them the colours must be less brilliant as they recede from the eye towards the distance wherein they are lost. This word must not be confounded with the term *effect*, though effect is doubtless the result of keeping in a picture, that word being more peculiarly applicable to the sensation produced by the combination of accidental circumstances in the disposition of light and shade.

Keilhauite or **Keilhaulite.** [YTTROTITANITE.]

Kelloways Rock. A calcareous bed at the base of the upper oolites of England, occupying a position between the Cornbrash and the Oxford clay. It is a thin bed, and of little importance, except as separating the upper from the middle oolites. It is purely local.

Kelp. A common term for seaweed or vraic, which consists of different species of *Fuci* and *Laminariæ*. In a strict sense, the term *kelp* is confined to the produce of seaweed when burnt, which consists of alkaline ashes used as a manure. For this purpose it is sought after by farmers on the sea coast, and especially by those who have dry soils, the salt contained in the kelp being an absorbent of moisture. It has also acquired much importance as a source of *iodine*.

Kelpies. In Scotch Mythology, certain supernatural beings, like Bogles and Brownies.

Kennel (Fr. chenil, Ital. canilo, from Lat. canis, *a dog*). A word denoting literally the house in which a pack of hounds is lodged, but used metaphorically for the pack itself. It signifies also the spot to which the fox after his nocturnal depredations retires about the dawn of day. Hence, on being found by the hounds in drawing cover, he is said to be *unkennelled*.

Kenngottite. A mineral bearing some resemblance to Miargyrite, but containing a larger amount of silver. It is found in irregular groups of crystals, varying in colour from iron-black to lead-grey, at Felsöbanya in Hungary. Named after Professor Kengott.

Kentish Rag. A tough calcareous stone used extensively for building, and remarkably durable. It is developed at Hythe and near Maidstone in Kent, and belongs to the lowest part of the cretaceous group of England, corresponding with the Atherfield beds of the lowest part of the lower greensand of the Isle of Wight. It is very local, as a valuable building stone, even where the other beds of the lower greensand are well shown. The lower Neocomian beds of France and Switzerland, and the lower Quader of Saxony, are probably of the same age, and the latter contains building stone also. The Kentish rag is brought to London, and carried to some distance for special purposes, where durability is required.

Kepler's Laws. In Astronomy, the laws of the planetary motions, first discovered and demonstrated by Kepler. They form the basis of the whole theory of gravitation and physical astronomy, and are three in number: 1. That the planets describe ellipses, each of which has one of its foci in the same point, namely the centre of the sun. 2. That every planet moves so that the line drawn from it to the sun describes about the sun equal areas in equal times. 3. That the squares of the times of the revolutions of the planets are as the cubes of their mean distances from the sun. These three laws or general facts were discovered by Kepler from a comparison of astronomical observations; and though it was by means of them that Newton established the more general law of attraction inversely as the square of the distance, they are themselves direct consequences of that hypothesis. The first law, that of the elliptic motion of the planets, was announced by Kepler in his famous work, *Physica Cœlestis tradita Commentariis de Motibus Stellæ Martis*, 1609. Kepler having com-

puted from the observations of Tycho Brahe the distances of Mars from the sun at different points of his orbit, found that the orbit was not circular, as had always been supposed by astronomers till then, but elliptical; and that the sun occupies one of the foci of the ellipse. He afterwards discovered the same thing to be true of the earth's orbit; and thence extended it by analogy to all the other planets. Newton demonstrated in the *Principia* that if a body projected in space is acted upon by a central force varying inversely as the square of the distance, the body will necessarily describe one of the three conic sections; but whether the orbit will be an ellipse, an hyperbola, or a parabola, depends on the intensity of the force with which it is projected.

Kepler was led to the discovery of his second law by a comparison of the sectors formed by two contiguous radii vectores and the angles included between them. The data which he assumed were not rigorously exact; but Newton afterwards demonstrated from the theory of dynamics that the fact is necessarily true of all motions regulated by a central force, whatever the law of that force may be.

The history of the discovery of the third law is remarkable. Kepler had long been persuaded that some numerical relation must exist between the periodic times of the planets and their distances from the sun. In order to discover this relation he tried successively many hypotheses, each of which involved a mass of tedious calculation. He began by comparing the intervals between the planetary orbits with the five regular solids; and having failed in this speculation, as well as in various others, he at length thought of comparing the different roots and powers of the periods and distances. After many attempts and failures, he at last perceived the analogy of which he had been so long in search.

—— sera quidem respexit inertem,
Respexit tamen et longo post tempore venit,

he exclaims; and in the fulness of his delight he has recorded the year and day on which the discovery was made. It was the 8th of May, 1618; and, as Professor Playfair has remarked, 'perhaps philosophers will agree that there are few days in the scientific history of the world which deserve so well to be remembered.' (Dissertation iv. *Encyclopædia Britannica.*)

Kepler's Problem. The discovery made by Kepler, that the planetary orbits are ellipses having the sun in the focus which is common to each ellipse, and that the line which joins the centres of the sun and a planet passes over equal areas in equal times, made it necessary to solve a problem which transcended the geometry of his age: Supposing the semitransverse axis of a planet's orbit to be represented by 1, and the eccentricity by e; also the mean anomaly at any given instant of time by z, and the eccentric anomaly by x, both being reckoned from the perihelion, Kepler found the relation between the angles x and z to be expressed by the equation $z=x-e\sin x$. When x is given, z is easily found from the trigonometrical tables; but there is no direct way, unless by infinite series, of finding x when z is given, which is the case that occurs in astronomy. The determination of x in terms of z constitutes what is called Kepler's Problem. Solutions of this important problem are to be found in most works on astronomy. They are generally tentative, depending on a combination of geometrical and trigonometrical principles; but two very elegant ones, purely analytical, are given by Professor Wallace, in the *Memoirs of the Royal Astronomical Society*, vol. ix. p. 185. The first of these solutions is as follows:—

1. Find x', a fir[s]t approximation to the eccentric anomaly x, by this formula,

$$\tan\left(x'-\tfrac{1}{2}z\right)=\frac{1+e}{1-e}\tan\tfrac{1}{2}z.$$

2. Find y such that

$$\tan\left(\tfrac{1}{2}x'+y\right)=\frac{1+e}{1-e}\tan\tfrac{1}{2}x'.$$

3. Find c, a correction of x', so that

$$\sin(y-c)=\frac{\sin y}{\sin x'}\cdot\frac{\sin 1''}{}(x'-z).$$

(Here $x'-z$ must be expressed in seconds of a degree.)

4. Then the eccentric anomaly, $x=x'+c$. The computation of the eccentric anomaly by this method is extremely simple.

Keramohalite. A hydrated subsulphate of alumina having the same composition as Aluminite. It occurs in crystalline crusts and in six-sided tables near Königsberg in Hungary, associated with Iron Vitriol.

Keraphyllite. A species of Hornblende. [CARINTHINE.]

Kerargyrite (Gr. κέρας, *a horn*; ἄργυρος, *silver*). Native chloride of silver. [HORN SILVER.]

Kerasite (Gr. κέρας). A synonym of chlorocarbonate of lead. [CROMFORDITE.]

Kerate. [HORN SILVER.]

Keratonyxis (Gr. κέρας, *a horn*, νύξις, *a puncturing*). A term applied by the German surgeons to the operation of couching, performed by introducing a needle through the cornea or horny coat of the eye, and depressing or breaking the opaque lens.

Keratophyllite (Gr. κέρας, and φύλλον, *a leaf*). A mineralogical synonym of Actinolite.

Keri-chetib (Heb.). In Philology, the name given to various readings in the Hebrew Bible. Keri signifies *that which is read*, and chetib *that which is written*. When any such various readings occur, the false reading or chetib is written in the text, and the true reading or keri is written in the margin, with ק under it. These corrections, which are about 1,000 in number, have been generally attributed to Ezra. (Kennicott, *Dissertatio Generalis.*)

Kermes (Arab. *little worm*). An insect found in many parts of Asia and the south of Europe, the *Coccus ilicis* of Linnæus. They were long taken for the seeds of the tree on which they live, and hence called *grains of kermes*. They

are used as a red and scarlet dye. Before the introduction of cochineal, kermes was the most esteemed drug for dyeing scarlet. The tapestries of Brussels and other parts of Flanders, which have lost little of their original brilliancy, even after a lapse of 200 years, were dyed with kermes. (Beckmann's *History of Inventions*; Bancroft's *Permanent Colours*.)

Kermes Mineral. A name given by the old chemists to the precipitated sulphide of antimony, in consequence of its reddish colour.

Kermesite. Native oxy-sulphide of antimony.

Kerned Letters. In Printing, those types which have their faces hanging over one or both sides of their shanks or bodies. In Greek, for example, where the vowels are almost always cast in this manner, the kerned *η* will admit all kinds of accents or breathings (each cast upon a separate piece of metal), and may become ή, ὴ, ῆ, ἡ, ἠ, ἧ, ἥ, ἕ, ἣ, ἤ, ἢ, ῆ, ἡ, ἦ, as required by the printer.

Kerodon (Gr. *κῆρ, a heart*; *ὀδούς, a tooth*). A genus of herbivorous Rodents, characterised by $\frac{4-4}{4-4}$ molar teeth, each composed of two equal parts, of which the transverse section presents a cordiform or heart-shaped figure; the two parts are united on the external side in the upper, and on the internal side in the lower jaw. The incisors are two in number in both jaws, and present the form common to the Cavies, to which family the present genus belongs. The species are small, scarcely equalling the Guinea-pig in size. They are peculiar, with the other Cavies, to the South American continent.

Kerolite (Gr. *κηρός, wax*, and *λίθος, stone*). A native hydrated silicate of manganese, which occurs in kidney-shaped masses of a white, yellow, or green colour, at Zöblitz in Saxony, Frankenstein in Silesia, and in Harford county, Maryland.

Kersey (probably a corruption of Jersey, whence it originally came). A kind of coarse cloth, usually ribbed, and woven from long wool. It is chiefly manufactured in the north of England. *Kerseymere*, on the other hand, is a thin stuff, generally woven plain from the finest wools; and hence it has been inferred that these two terms, the meaning of which is so distinct, cannot be referred to the same origin. Kerseymere is said to have derived its appellation from Cashmir, a country which produces the finest wool and is celebrated for the works of its looms. In England it is principally manufactured in the western districts.

Kestrel. The *Falco Tinnunculus* of Linnæus, one of the common English birds of prey.

Ketch (Dan. kettsch; Dutch, kits). An almost obsolete form of two-masted vessel, carrying a tall mainmast and shorter mizzen. It was a favourite form for yachts, and more especially for mortar-vessels.

Ketchup. A name of Eastern origin, said to come from kitjap, the Japanese name for some similar condiment. With us it is usually prepared from mushrooms, champignons, and similar fungi, by sprinkling them, when broken up, with salt, and boiling the expressed juice with spice. Mr. Berkeley, one of our most learned fungologists, states, however, that the better plan is to let the juice strain without squeezing, and after standing for twelve hours to rack it off clear and bottle it, filling the top of the bottle up with alcohol, in which the proper spices have been previously steeped. Prepared in this way, it retains its peculiar flavour more perfectly than when boiled. Ketchup is often prepared for sale from agarics collected almost indiscriminately, no care being taken to discard poisonous species. The best ketchup is prepared from *Agaricus campestris*, but a very good quality may be obtained from an admixture of other species, especially *A. procerus*, if care is used. Walnut ketchup, a similar preparation from green walnuts, is also of frequent use in domestic economy.

Ketones or Acetones. A term used by some chemists to designate a product of the dry distillation of the baryta, lime, or lead salts of the volatile acids. Amongst these products is a compound which has been termed the *ketone* of the acid, and which bears the same relation to the acid from which it has been obtained, as *acetone* does to *acetic acid*. [ACETONE.]

Keuper. The uppermost division of the *Trias* of continental geologists. It consists generally of a series of variegated marls (*marnes irisées*), of red, grey, or blue colour, passing into green marls, black clay, and fine-grained sandstones. Rock-salt and gypsum abound in these deposits, and the upper members of the new red sandstone of Cheshire and other parts of England are also characterised by the presence of the same minerals.

The keuper contains not unfrequently remains of plants distinct from those of the coal measures, and even from those of the *Bunter sandstein*, the lowest division of the Trias.

Kevels (called also Ranges). On Shipboard, timbers projecting at a small angle from the sides, to which are belayed the sheets and tacks by which the mainsail and the foresail are extended. *Kevel heads* are the ends of certain top timbers which, projecting above the ordinary line of gunwale, form bitts round which ropes can be made fast.

Key (A.-Sax. cæg). In Architecture, a piece of wood let into the back of another in the contrary direction of the grain, to preserve the last from warping. The term is also applied to the portion of lime and hair rendering that forces its way between the joints of the laths, in plasterer's work, and serves to uphold the body of the work.

Key or Key Note. In Music, the principal or fundamental note in a composition, on which frequent closes or cadences are made. It is that in which the piece usually begins and ends, and is, as it were, the musical standard to which regard must be had in all the other combinations of sounds in the composition, and

under whose influence they are. [TONIC.] The key of a composition may be either major or minor, according as the scale has a major or a minor third.

Key Stone. The middle voussoir of the arch of a bridge, or the arch stone at the crown or immediately over the centre of the arch. The length of the key stone, or thickness of the archivolt at the top, is usually made about $\frac{1}{15}$ or $\frac{1}{18}$ of the span by the best architects. The practice of engineers is rather different; it is based upon the empirical formula derived from Perronet's experience, in which, calling e the thickness, then

$$e = 0{\cdot}0347\, d + 0^{m}{\cdot}325\,;$$

d representing tne span if the vault be semicircular, and double the radius if the vault be over the centre. The dimensions above quoted are in mètres.

Key-board. In Music, the series of levers in a keyed instrument, as a pianoforte, organ, or harpsichord, upon which the fingers press to produce percussion of the strings, or in the organ the opening of valves. It consists of short black and long white keys.

Keyser's Pills. A once celebrated mercurial preparation, the active ingredient in which is the *acetate of mercury*.

Khalif. [CALIPH.]

Khan. In Persia, properly speaking, the title of an officer or governor, added after his name. The sovereigns of many independent states of Northern Asia are styled *khans*. Khan is frequently used by our own countrymen to signify an Eastern CARAVANSERA [which see]; in which travellers find a gratuitous lodging, provided their stay be limited to a single night.

Khât. [KÂT.]

Khay. A Senegal Cedrelaceous tree, called *K. senegalensis*, the bark of which is used as a febrifuge on the banks of the Gambia, and the wood of which resembles mahogany. It is, in fact, closely allied to the mahogany-tree, *Swietenia Mahagoni*.

Khotbah (Arab.). A peculiar form of prayer used in Mohammedan countries at the commencement of public worship in the great mosques on Friday at noon. It was originally performed by the Prophet himself, and by his successors till the time of Mohammed VIII. (A. D. 936), who appointed special ministers for the purpose, on which footing it has continued to the present time. The khotbah is chiefly a 'confession of faith,' and a general petition for success to the Mohammedan religion. It is divided into two distinct parts, between which the officiating khatib or priest makes a considerable pause, and is regarded by the Mussulmans as the most solemn and important part of their worship. The insertion of his name in this prayer has always been considered one of the chief prerogatives of the sultan of Turkey.

Khus-khus or Cuscus. The fragrant Indian grass *Andropogon muricatus*.

ase (Gr. *κίβδηλος, spurious*) or

Axotomous Iron-ore. A slightly magnetic titaniferous iron-ore from Gastein.

Kidnapping (a word of doubtful origin: Mr. Wedgwood refers it to nab = *steal*, and kid [slang] = *child*). In Law, the forcible abduction of anyone from his own country into another. It is an offence at common law. By 11 & 12 Wm. III. c. 7, penalties were denounced against masters of vessels having on board persons who had been kidnapped against their will. This enactment was probably occasioned by the practice, not uncommon in those days, of carrying away by force or fraud labouring persons to serve in the plantations in America. This clause is repealed by 9 Geo. IV. c. 31, by which masters of vessels are made punishable for leaving abroad any of their men against their will, an offence now punishable under stat. 17 & 18 Vict. c. 104 s. 206. The stealing of children away from persons having the lawful custody of them (popularly termed *kidnapping*) is felony under stat. 24 & 25 Vict. c. 100.

Kidneys. The organs in which the urine is secreted: there is one on each side in the loins, near the first lumbar vertebra, and behind the peritonæum. The pelvis of the kidney terminates in the ureter, and is divided into several portions called *calyces*, into each of which a papilla projects, through the minute orifices of which the secreted urine passes into the cavity called the pelvis, and thence by the ureter into the bladder. [RENAL ORGANS.]

Kiesel Schiefer (Ger.). A peculiar siliicious schist of the lower division of the upper carboniferous series of the Rhine is thus named. This schist is often black and loaded with carbon. It is found in other countries not unfrequently in the same state and association.

Kieserite. A sulphate of magnesia found at the Stassfurth salt mine, near Magdeburg.

Kigelia (Mozamb. Kigelikeia). The name of a genus of African *Crescentiaceæ*, the only species of which, *K. pinnata*, is a large spreading tree, with pinnate leaves, and long pendent fruit. The latter, when roasted, are used as an outward application in rheumatic complaints; and the tree itself is held sacred in Nubia, the negroes celebrating beneath it those religious festivals which take place by moonlight.

Kikekunemalo. A resin, resembling copal brought from America, where it is used medicinally. It forms excellent varnishes.

Kilbrickenite. A bluish-grey variety of sulphide of antimony and lead, found in Ireland at Kilbricken, Clare county.

Kilkenny Coal. [ANTHRACITE.]

Killas. A Cornish name for the clay slate which forms what is called in mining language the *country*, in those parts where mineral veins are worked. The name is applied very indefinitely by miners, and has no strict geological use or meaning.

Killinite. A mineral, sometimes described as a variety of Spodumene, from Killiney, near Dublin. It is a hydrated silicate of alumina, containing potash and oxide of iron.

Kilogramme. A French measure of weight equal to 1,000 grammes, and to 2·2046 lbs. avoirdupois.

Kilomètre. A thousand mètres; equal to 1,093½ yards nearly.

Kilt. A loose dress, extending from the waist to the knee in the form of a petticoat; worn in the Highlands by men, and by children in the Lowlands. The term is, according to Jamieson, unquestionably Gothic. The Highlanders designate the kilt as the *filib g*. This singular national dress is fast hastening into disuse; and but for a few Highland regiments in which it is still maintained, it would probably long ago have been universally superseded by the dress of the Lowlanders.

Kimeridge Clay. A blue slaty clay, containing carbonate and sulphate of lime. It is a thick and important deposit in the south of England, where it forms the base of the upper division of the oolites, and contains a bituminous shale called the Kimeridge coal. In France, there is a corresponding bed of clay at Honfleur, at the mouth of the Seine. In the north of Bavaria the celebrated lithographic slates of Solnhofen replace the clays. A small oyster called the *Gryphæa virgula* is very characteristic of this part of the oolitic series. The Portland beds overlie the Kimeridge clay.

Kimeridge Coal. A remarkably bituminous shale, found in the Kimeridge clay beds on the south coast of England. It is of dark brown colour and without lustre, it effervesces slightly with acids, contains no iron pyrites, and burns readily with a yellowish, rather smoky and heavy flame. It is associated with slaty pyritous clays. It has been used for burning with little advantage. It would probably better repay distilling, were it not for the disagreeable odour of the oil obtained from it.

Kinematics (Gr. κίνημα, *a motion*). The science of pure motion. It differs from geometry by the admission of the conceptions of *time* and *velocity*, and from dynamics proper by the exclusion of the conception of *force* as a cause of motion. Roberval's method of tangents and Newton's fluxions are purely kinematical methods. From the kinematics of a point all the properties of curves may be deduced, and that frequently with great simplicity. A curve, in fact, may be conceived to be generated by a point moving along a line which at the same time incessantly turns around that point, a definition by which Lamarle has profited in his *Théorie Géométrique des Rayons et Centres de Courbure* (*Bulletins de l'Acad. Roy. de Belgique*, tomes 2, 3, 5, 6, also *Exposé Géométrique du Calcul Différentiel et Intégral, précédé de la Cinématique du Point, de la Droite et du Plan*, Paris 1861). The line is the tangent of the curve, and the relative velocities of translation and rotation determine its curvature.

The motion of a rigid body or of an invariable system of points is determined, of course, by that of any three points, or of the plane containing these three. Now, by the theory of rotations [ROTATIONS, COMPOSITION AND RESOLUTION OF] any position whatever can be given to such a plane, by imparting to it a helical motion around a given axis, the *central axis*. Further, the motion of such a plane at any instant may not only be regarded as consisting of a simultaneous sliding along, and rotation around the central or, as it is often called, the *instantaneous sliding axis*; it is also equivalent to two simultaneous rotations, without sliding, around two axes which do not intersect one another, and to which the name of *reciprocal* or *conjugate lines* has been given. The number of pairs of reciprocal lines having the above property is infinite; one line, however, being chosen arbitrarily, the other is perfectly defined. The mutual inclination of two such reciprocal lines varies from zero to a right angle, and amongst the pairs at right angles to each other, one always lies in the plane under consideration, of which it is called the *characteristic*, and the other cuts the plane perpendicularly in a point to which the name of *focus* has been given. These terms were introduced by Chasles, whose memoirs on the subject in the *Comptes Rendus de l'Acad. des Sciences*, 1843, are well worthy of study. The first is obviously in accordance with Monge's definition of a characteristic, since it is the line common to two consecutive positions of the moving plane.

King. A title of dignity in the languages, extinct and living, of the Teutonic and Gothic races. There is some difference of opinion as to the origin of the word; probably as *kon-ung*, *cyn-ing*, it expresses one chosen from the people to rule them, the termination appearing in such words as ætheling, while the first syllable, connected with the Greek γένος, Latin *gens*, &c., appears also in γυνή and *quean*. It would therefore primarily mean one chosen from and by the people to represent and guide them; but it has passed through as many shades of meaning as there are states or nations to be governed. Thus it is applied equally to the constitutional sovereign of England and the absolute sovereign of Prussia; to the chief magistrate of Poland in former times, who was *elected*, and to that of England, who succeeds by *hereditary* right; to the head of a savage tribe or barbarous horde, as well as to that of the most refined and civilised nation. It is expressed in Greek by the word *basileus*, and in Latin and its cognate languages by *rex*; but all the nations of Europe have adopted into their respective languages the equivalent terms in use among the people with whom they carry on intercourse. Thus we speak of the Shah of Persia, the Grand Sultan, the Pasha of Egypt, the Dey of Algiers, &c.

In countries where the kingly office is hereditary, some form has always been gone through on the accession of a new king, in which there is a recognition on the part of the people of his right; a claim from them that he should pledge himself to the performance of certain duties; and generally a religious ceremony performed, in which the

anointing him with oil and placing a crown upon his head are conspicuous acts; the whole solemnity being styled the coronation. In modern Europe the Pope and the Emperor assumed as a joint prerogative the right of conferring the dignity of king. Frederick I. of Prussia was the first sovereign who assumed the title, and had it acknowledged by the other states of Europe without their authorisation.

In Great Britain, the king exercises the supreme executive power, together with a share in the legislative authority jointly with the two houses of parliament. [PARLIAMENT.] The right to the throne of England (now extended to Great Britain and Ireland) is hereditary, subject to the authority of parliament to limit the succession. This was last done by the stat. 12 & 13 Wm. III., when it was fixed in the heirs of the electress Sophia of Hanover, being Protestants. The duties of the king according to the constitution are embodied in the coronation oath, fixed by stat. 1 Wm. & Mary. Incidental prerogatives are legal exceptions in favour of the crown where its claims clash with those of a subject; relating to such matters as descents of lands, debts, &c. The direct prerogatives of the crown are those which attach to the king in respect of his political authority: such as the sanctity of his person; his prerogatives as head of the executive; the power of making war and peace; treaties with foreign powers; military and naval command; the supreme dispensation of justice through his courts; the power of erecting and disposing of offices and honours; the power of issuing proclamations binding on the subject in certain cases, with the advice of his privy council; and, lastly, the supreme government of the national church. The king's revenue is of two sorts, ordinary and extraordinary. The ordinary revenue or patrimony is such as either has subsisted in the crown time out of mind, or has been granted by parliament in exchange for such. [CIVIL LIST.] The extraordinary revenue consists of the supplies annually granted by parliament. [PARLIAMENT; PREROGATIVE.]

King Crab. [LIMULUS.]

King Fish. A name sometimes applied to the *opah* (*Lampris guttatus*, Retz.).

King Post. In Architecture, the middle post of an assemblage of trussed framing, for supporting, or rather for suspending, the tie-beam, at the middle, and at the lower ends of the struts. In framed partitions the king post is introduced in the centre of the span, and has the discharging pieces framed into it in either side.

King's Advocate. The Advocate representing the crown in the Ecclesiastical and Admiralty Courts.

King's or Queen's Bench, Court of. In Law, this court originated in the ancient Aula Regia, in which the king was accustomed (as he still is supposed in the King's Bench by fiction of law) to sit in person, and which followed him in all his progresses. The judges of the court of King's Bench, as well as of the other superior courts, formerly varied in number according to the royal discretion. At a later period they were reduced to four; now increased, by stat. 1 Wm. IV. c. 70, to five—the chief justice, who [illegible]

puisne or *younger* judges. The Court of King's Bench, besides those branches of its jurisdiction which it has in common with the other two superior common law courts [COURTS, SUPERIOR], has also peculiar authority, or presents more advantages in some particular proceedings.

It is the preferable although not the only tribunal for discharging prisoners under the Habeas Corpus Acts. It has control over all inferior courts by means of the process called *certiorari*, which is a writ sued out of this court, by virtue of which proceedings may be removed into it out of such inferior jurisdiction, whether in criminal or civil cases. It has also an exclusive authority (except in a few cases) to compel all inferior courts and officers, and in some instances private persons, to perform acts of a public nature, and connected with a public duty. By means of a *prohibition* it can restrain all other courts from proceeding where they exceed or misuse their jurisdiction: this is likewise a writ directed to the judge and the plaintiff in the inferior court. A writ of error in law from all *inferior courts* is, with certain exceptions, returnable in the King's Bench. This court likewise hears and determines cases stated by courts of sessions. The greater proportion of these are questions on the validity of poor's rates, or on parochial settlements. When a court of sessions entertains a doubt on a point of law arising in the argument, it will usually authorise the party against which it decides to have the judgment thus reviewed, the cases being stated in writing. The criminal jurisdiction of the King's Bench is still extensive. It has, at common law, jurisdiction by indictment over every species of criminal offence committed in Middlesex; and in practice misdemeanours, as conspiracies or perjuries, committed in the county, are still indicted in this court, and tried after term at nisi prius among the civil causes. Sometimes also trial at bar, or by the full court, is granted on special application. It has also jurisdiction by criminal information, which lies in cases of misdemeanour only; a proceeding which supersedes the necessity of an indictment found by a grand jury. An information is filed either by the attorney-general *ex officio*, as it is termed—a proceeding generally adopted in certain misdemeanours of a public nature; or at the suit of a private party by leave of the court.

An information in the nature of a *quo warranto* is in form a criminal, but substantially a civil proceeding. It is granted where any subject or body politic has assumed a franchise or privilege not being legally entitled, and to the injury of some other party or the public. Any indictment, presentment, &c. found in any part of England, may be moved by *certiorari* into this court; as may be also all convictions or orders of justices of the peace, unless where such appeal is prevented by particular statutes.

King's Evil. Scrofula attacking the glands, respecting which a superstitious notion long existed that it was curable by the touch of royalty.

King's Yellow. A pigment, the basis is *orpiment*, or yellow sulphuret of arsenic.

King-at-Arms. An officer of great antiquity, and formerly of great authority, whose business is to preside over the chapters, and to direct the proceedings of heralds. The origin of this office is involved in obscurity. There are three kings-at-arms in England—Garter, Clarencieux, and Norroy; the first of whom is styled *principal king-at-arms*, and the two latter *provincial kings*, because their duties are confined to the provinces. The name Clarencieux is said to be derived from Clarence, brother of Henry V., first king-at-arms for the south of England; that of Norroy (Norman-French for *northern king*) is self-explanatory. There is also a Lyon king-at-arms for Scotland, as well as an Ulster king-at-arms for Ireland, whose duties are nearly analogous to those of England. (Noble's *History of the College of Arms.*)

Kingfisher. [ALCEDO; HALCYONIDÆ.]

Kingston. A name sometimes given to the angel-fish (*Squatina angelus*, Dunn.).

Kinic Acid. The acid with which quinia and cinchona are combined in yellow and pale Peruvian bark. [CINCHONIC ACID.]

Kink. In a rope or chain, a curvature reduced to a sharp bend by the too rapid drawing from a coil or twist. It is very dangerous on shipboard, causing a stoppage in the run of tackle through blocks, and weakening the rope by a sudden reversal of the direction of the strain. The best rope kinks very seldom.

Kinkajou. The native name of a Plantigrade quadruped of South America, of arboreal habits, with a long prehensile tail, a short muzzle, and a thick coat of woolly hair. It forms the type of the genus *Potos* of Cuvier, which name Illiger changed to *Cercoleptes*. Only one species is well established, the *Cercoleptes caudivolvulus* of Illiger.

Kino. An Indian word applied to certain astringent vegetable extracts. The finest kino is in brilliant fragments of a deep brownish red colour, and highly astringent; it contains tannin, gum, and extractive matter, and is used in medicine as an astringent. Indian kino is said to be the produce of *Pterocarpus Marsupium*; and African kino that of *Pterocarpus erinaceus*. The inspissated juice of *Eucalyptus resinifera* is sometimes called Botany Bay kino.

Kinone. *Kinöil.* An organic substance in golden-yellow crystals, produced when kinic acid is distilled with peroxide of manganese and sulphuric acid. Kinone has also been found among the products of the dry distillation of coffee.

Kiosk. A Turkish word, signifying a kind of open pavilion or summer house, supported by pillars. These ornaments have of late years been introduced to a considerable extent into the gardens of European countries.

Kirk (Ger. kirche). A Scottish term synonymous with *church*, and used chiefly to designate the form of religion established in that country. [PRESBYTERIANISM.]

Kirk Session. The lowest ecclesiastical court of the kirk of Scotland. It is composed of the minister of the parish and of lay elders. It takes cognisance of cases of scandal, of the poor's fund, and of matters of general ecclesiastical discipline. There is an appeal from its decisions to the presbytery.

Kirschwasser (Ger. *cherry water*). An alcoholic liquor obtained by fermenting the small and sweet black cherry. The liquor produced is distilled, and often flavoured with hydrocyanic acid, derived from the bruised kernels of the fruit; this gives to kirschwasser, when sweetened, the character of noyau.

Kirwanite. A hydrated silicate of alumina, lime, and protoxide of iron—probably a variety of Green-earth. It occurs in small nodules of a dark olive-green colour, with a fibrous and somewhat radiated structure, in the basalt of the Mourne Mountains on the north-east coast of Ireland. Named after Richard Kirwan, the mineralogist.

Kish. A substance occasionally produced in iron smelting furnaces; in appearance it resembles plumbago, but is said to consist chiefly of carbon and manganese.

Kistvaen. [CESTVAEN.]

Kit (Dutch, *a back load*). The clothes and personal appointments of a soldier. Every recruit, upon being finally approved, receives a free kit, including all those articles known as regimental necessaries, which he is bound to keep constantly complete and in good order.

Kit Cat Club. The name of a celebrated association, instituted about 1688 by 'some young men of wit and pleasure about town,' originally for convivial purposes; but as its most distinguished members were Whigs in politics, it gradually assumed a political character, till in the reign of Queen Anne it came to be regarded as exclusively political in its objects. At that period it comprised above forty noblemen and gentlemen of the first rank and fortune, firm friends to the Hanoverian succession; among whom were Addison, Steele, Marlborough, Walpole, &c. &c. It was originally formed in Shire Lane, and derived its name from one Christopher (Kit) Kat, who supplied the members with mutton pies. The fame of this club has been transmitted chiefly by the collection of the portraits of the members painted by Sir Godfrey Kneller, himself a member, who was obliged to invent a new-sized canvas accommodated to the height of the walls; whence has originated the application of the epithet *kit cat* to any portrait about three-quarters in length. It was dissolved in the year 1720. (*Quarterly Review*, vol. xxvi.)

Kite (Welsh cûd). The native bird so called is a species of the genus *Milvus*, separated by Bechstein from the genus *Falco* of Linnæus on account of the forked tail, length of wings, and the short and weak beak and feet in

proportion to the size of the body. This deterioration of their destructive instruments renders the kite the most cowardly of the birds of prey. The common kite, or glede (*Milvus vulgaris*), preys chiefly on the smaller quadrupeds and birds, young chickens, &c.; yet the courage of the mother hen renders her more than a match for the robber, and she generally repels his attacks on his favourite prey. The female lays two or three eggs of a whitish colour, spotted with pale yellow, and of a roundish form.

The term *kite* is applied in some places, as Devonshire and Cornwall, to the brill (*Rhombus vulgaris*).

Kite. A well-known toy; first employed by Romas in France, and Dr. Franklin in America, to elevate a conductor into a thunder-cloud, whereby the identity of lightning with the electric spark was ascertained. It is formed of a slender frame of wood and pack-thread, rounded at one end and terminating in a point at the other, resembling in some measure a cross-bow, and covered with paper. A long string is attached to the frame, near its centre of gravity, by which it is held in the hand. In order that the kite may be capable of being raised, it is necessary that its flat surface be presented obliquely to the direction of the wind; a string or *tail*, carrying some light substance, is therefore attached to the sharp end of the frame, and serves by means of its gravity to maintain the proper inclination. The force of the wind, impinging obliquely on the surface, is resolved into two parts, one perpendicular and the other parallel to the surface; the first of these parts is counterbalanced by the tension of the string held in the hand, and the second is expended in elevating the kite. The position in which the wind acts with the greatest effect is when the perpendicular to the surface is inclined to the direction of the wind (that is, to the horizon) in an angle of about $54\frac{1}{2}$ degrees.

Kitt Composition. A material composed of: resin 7 lb. 8 oz., pitch 6 lb. 14 oz., beeswax 6 lb. 14 oz., tallow 1 lb. 14 oz., boiled together over a slow fire. It is used to render canvas waterproof. It is not permeable to water, and sticks firmly to metallic substances.

Kittool or **Kittul.** Cinghalese names for the strong fibre obtained from the leaf-stalks of the palm called *Caryota urens*.

Kivi-kivi. The native name of the New Zealanders for their singular bird the *Apteryx australis*. [Apteryx.]

Klaprothine. A name for Lazulite, after the celebrated German chemist, Klaproth.

Klinometer (Gr. κλίνω, *I incline*; μέτρον, *measure*). An instrument for measuring the angles of the dip of strata.

Knaurs. In Botany, the knots or tumours sometimes found on the stems or roots of plants.

Knebelite. A mineral from an unknown locality, named after Major von Knebel. Probably it is a ferruginous Tephroite, or silicate of iron and manganese.

Knee (Gr. γόνυ, Lat. genu, Ger. knie). In Architecture, a naturally or artificially bent piece of timber, on which another is received to relieve a weight or strain; the term is also applied to wrought-iron knees, for the same purpose.

Knee. In Shipbuilding, an angle, formerly of timber, but in modern times nearly always of iron, for bracing together internally parts which form angles with each other. The principal knees are those supporting the beams, and fastened to them and to the ribs. There are, however, various other knees in different parts of the ship. They tend to bind the whole vessel into one hollow body, in which the parts are mutually dependent. The *knee of the head* sustains the figure-head and the projecting bow above the water-line: it is braced on to the stem.

Knee Pan. A small flat heart-shaped bone placed at the fore part of the knee joint. It is an important defence to that large joint, and also serves to increase the powers of the muscles which extend the leg. It is attached by a strong ligament to the upper end of the tibia.

Kneph. The ram-headed god of ancient Egypt, known by the name Amen-ra, or, in its Greek form, Ammon [which see].

Knight, Knighthood (A.-Sax. cniht, Ger. knecht, *a lad*; hence *a man-at-arms*: cf. Infantry]. According to Tacitus and other writers, the ancient German kings and chiefs were attended in war and peace by a select body of faithful companions. Kings, great thanes, and aldermen had each among the Anglo-Saxons their attendant cnihts or military servants, who owed them a species of fealty rather personal than territorial. But the order of knighthood, in the more recent sense of the word, was introduced among us from France. Among the French and Germans, indeed, the order of knights was designated by another name—*chevalier* or *ritter*, from their serving on horseback in battle, and holding a rank above the footmen. But the Norman chevalier so completely answered to the Saxon cniht in the peculiar attribute of being personally attached to the military service of some chieftain, that the English appellation was soon in general use, as if to express the same meaning conveyed by the French title, and by its Latin equivalent *miles*. The Anglo-Saxons appear, indeed, to have occasionally practised long before the Conquest some ceremonies resembling those which became usual in later times on the creation of a knight; thus Alfred is said to have honoured Athelstan by the gift of a belt and robe, and by girding him with a sword.

It is said in general, but on doubtful evidence, that knighthood had become an established institution in the eleventh century; but that the characteristic which belonged to it in later times, of being restricted to men of noble birth, did not become general until the fourteenth. The privilege of conferring knighthood seems to have belonged originally to the sovereign, and to have been retained as his prerogative in

all European constitutions, although frequently delegated to or usurped by high feudatories, generals of armies, &c. In later times, and when knighthood had assumed its peculiar romantic character, the most distinguished and valorous knights were allowed to confer it, and kings themselves sought for the distinction of knighthood at their hands.

It was common to create knights on various occasions. The most honourable species of knighthood was that conferred on the field and after a battle; but the more common fashion, especially in France, the parent country of chivalrous institutions, was to make knights when a battle was expected. Five hundred were created at once in the French army before the battle of Agincourt. Knights were also created on other solemn occasions; as great festivals, coronations, princely marriages, &c.

In describing the ordinances of knighthood as they existed when that institution was brought to the point of imaginary perfection, the period to which we must refer is the fourteenth century; and the countries chiefly France, Germany, and England. In Italy and Spain, and generally in other parts of Christendom, the chivalrous customs of the first-named regions were imitated, but do not appear to have grown up spontaneously as part of the popular usages. Before this epoch, indeed, the Crusades had communicated to the institution much of its religious character; and the poems of the Troubadours and Trouveurs attest how much of gallantry had already been fancifully interwoven with the military habits of the age. But it was not, perhaps, until the time when the favourite fictions of romance had begun to act strongly on the popular imagination, that the ideal usages of chivalry were completely engrafted in practice on the substantial institution of knighthood. [CHIVALRY.]

The orders of chivalry were three. The future knight was first educated, in general, as a page attached to the family, and especially to the ladies of some noble house: when of full age, he became a squire (écuyer). The proper office of the squire, in the theory of chivalry, was, as his name of *shield-bearer* denotes, to attend on the person of a knight, to whom he was bound to render devoted and faithful service. In this capacity he was a sort of apprentice to knighthood; but as many esquires never reached the order of knighthood at all, but remained independent, the rank of esquire, in ordinary usage, became an intervening order between the knight and the simple gentleman: in which sense it is still retained in England. The order of knighthood followed this double probation. Knights, however, were often made without having passed regularly through the intervening stages; and even in the age of chivalry, the honour was occasionally conferred on mere children; although his was an evident abuse, and regarded as such. When the order of knighthood was conferred with full solemnity in the leisure of a court or city, imposing preliminary ceremonies were required of the candidate. He prepared himself by prayer and fasting, watched his arms all night in a chapel, and was then admitted with the performance of religious rites. Knighthood was conferred by the *accolade*, which, from the derivation of the name from the Latin collum, *the neck*, would appear to have been originally an embrace; but afterwards consisted, as it still does, in a blow of the flat of a sword on the neck of the kneeling candidate. The oath of knighthood was previously administered. This oath contained at different times various fanciful clauses: in France there were twenty vows comprised in it.

Knighthood was an institution which served in some respects as a compensation for the inequalities of rank incident to the feudal system. All knights, from the king to the lowest bachelor, were brethren of the same order; and when chivalry was in its most flourishing state, it may almost be said that they were all of the same country. National distinctions had little place between knights, who were enemies only in time of warfare, owing to their feudal duties, which attached them to the banner of a particular king or suzerain. At tournaments, court festivals, &c., in time of peace, knights of all nations were admitted indifferently; and the candidate for knighthood sought that honour at the hands of the most distinguished name in chivalry rather than of a countryman. The chief distinction of rank which subsisted between knights, in France and England, was rather of a feudal than a chivalrous character; it was that of knights-bachelors and knights-bannerets. The knight-bachelor was of the lower order. His name has been variously derived. [BACHELOR.] But in the more chivalrous times (as in all later periods) this honour was conferred without any reference to a qualification of property. Many knights-bachelors were, in fact, mere adventurers, unconnected by feudal ties of any sort, who offered their services in war to any successful leader, and who found in their sword a means of subsistence, not only by pay and plunder, but by the regularly established system of ransom which every knight taken in action paid for his liberty. The *chevalier-banneret* was one who possessed fiefs to a greater amount, was obliged to serve in war with a greater attendance, and carried a banner. Under Charles VII. the bannerets of France made remonstrances against the services required of them, on the ground of their impoverishment by the English wars; and it appears that this order fell afterwards into disuse in that country. In England the distinction appears to have been of a somewhat different character. The *knights' fees*, into which England was divided by the Conqueror, were such portions of land as could maintain a simple knight or bachelor; and by a statute of Edward II. persons who had the amount of 20*l.* a year in fee, or for life, were obliged to take this order of knighthood. This statute grew into disuse, except when occasionally put in force, as it was for the last

time under Charles I., as a means of extorting money, by way of fines, for not taking up the order. Bannerets, on the other hand, in England appear to have been such knights as were made or promoted from the lower degree on the field of battle. [BANNERET.] The distinction in the field between the different orders of chivalry was, at least at one period, the following: The esquire bore the *pennoncel* or triangular streamer; the knight-bachelor the *pennon* or forked streamer (swallow-tailed), made by dividing the end of the pennoncel; the banneret a banner (which was in strict usage of an oblong shape, barons being entitled to the square banner). Thus, when a banneret was made on the field, the ceremony was accomplished by cutting off the forked end of his pennon and converting it into a banner. Common knights and esquires were then under his command.

The confinement of the order of knighthood to men of noble birth (on the Continent, for the strict line of demarcation between nobility and commonalty was never accurately drawn in England), although necessary in theory to the completion of the chivalric system, tended in practice to its decay. Knighthood, after the fourteenth century, became more and more an honorary distinction, to which birth alone gave a title, and which was not considered to represent any actual duty or service; and finally, through various steps, it became again a mere personal distinction, which it was part of the sovereign's prerogative to confer, either on military persons or any others; and by the multiplication of orders, for admission into which nobility of birth was not always a necessary qualification, this peculiar property of the knightly order became again effaced. There are, however, in most Continental countries, several orders into which nobility still constitutes a necessary title for admission.

Orders of knighthood are of two classes: either they are associations or fraternities possessing property and rights of their own as independent bodies, into which knights are admitted as members into a religious foundation; or they are merely honorary associations, established by sovereigns within their respective dominions, consisting of members whose only common tie is the possession of the same titular distinction. To the former class belonged the three celebrated religious orders founded during the Crusades—TEMPLARS, HOSPITALLERS, and TEUTONIC KNIGHTS [which see]; which were societies, not belonging to any particular crown or realm, possessed of extensive property, and acting in some respects as independent republics. Several of the Spanish and Portuguese orders of knighthood partake of both characters: they were originally religious, but have become secular. The kings of those countries, as grand masters, exercise the privilege of admission, and make use of it as a means of conferring distinction; but the knights as a body form an independent society possessed of property and privileges [ORDERS OF CALATRAVA, ALCANTARA, &c.] The other class, consisting of orders merely titular, embraces most of the European orders, including all those of our own country. These were probably founded in imitation of the great military societies; although antiquarians have traced real or imaginary orders of knighthood under the reigns of princes of much more remote date, as Charles Martel, Charlemagne, &c. But these accounts are apocryphal: and no subsisting order of knighthood is of the date of the Crusades, except a few of those in Spain and Portugal, which, as we have said, were framed on the model of the great societies first mentioned.

Knight Errant. In the language of Chivalry, a knight wandering in search of adventures, sometimes under vows, for a certain period. Knight errantry was not altogether a fiction of romance. It originated, as Mr. Turner says, partly from the frequency of private war in feudal times, which made military aid constantly acceptable to the great barons; and as a knight had, for the most part, no other tie to the soil than his duties towards his feudal superior, he was at liberty to follow his own bent whenever his services were not needed by him. Such a mode of life peculiarly suited the tastes of the men of that age, and in some degree served the exigencies of society. 'Knights, therefore, were perpetually errant, or travelling in quest of adventures or employment; some from the pleasure of the expedition, and some for its expected profits. They often met the oppressed or the unsuccessful, and they cheerfully engaged themselves to redress those wrongs which laws were too feeble to remedy, and for redressing which, honour, plunder, or rich donations became usually their compensation.' (Turner's *History of England during the Middle Ages*, ch. xiii.)

Knight Service. Servitium Militare. The tenure by which a knight held his land. [FEUDAL SYSTEM.]

Knight of the Shire. The designation given to the representative in parliament of English counties at large, as distinguished from such cities and towns as are counties of themselves (which are seldom if ever called shires); and the representatives of which, as well as the members for other cities and towns, are called *citizens* or *burgesses*. It was formerly imperative on knights of the shire, as well as their choosers, either to be resident or to have a household in the county; but this regulation, which had long fallen into disuse, was formally repealed by 14 Geo. III c. 58.

Knight's Fee (Low Lat. Feodum Militare). In the language of English feudal usage, a portion of land held by custom sufficient to maintain a knight to do service as such for the king. William the Conqueror by his military grants is said to have created 60,000 such fees. But although William's vassals were undoubtedly bound to follow him to war, it is doubted by modern antiquarians whether feudal services, strictly so called, were attached to these grants by the Conqueror, or whether they were not peculiarities arising subsequently when the

feudal system grew into vigour, and attributed to the Conqueror by the legists of later times.

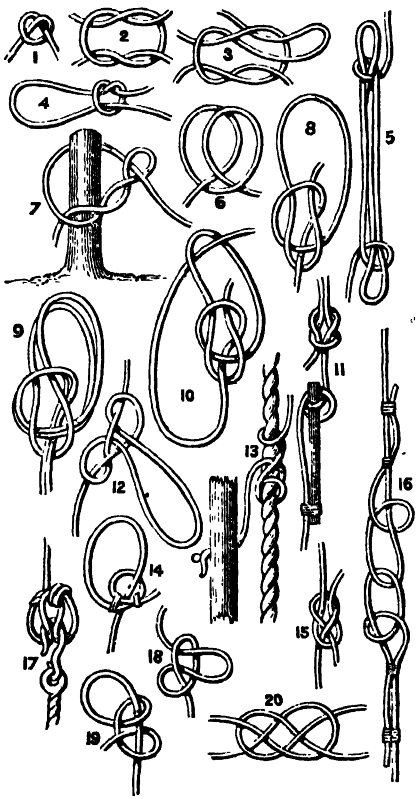
Knightheads. In Shipbuilding, the first cant timbers on each side of the stem. They serve to form a bed for the reception of the bowsprit.

Knoll (A.-Sax. cnolle, Ger. knollen). A term used in many parts of England for the pinnacle of a small hill, or for the hill itself.

Knoppern (Ger.). A species of gall-nut or excrescence formed by the puncture of an insect upon several kinds of oak. They are flat, hard, and prickly; they abound in Croatia, Styria, Slavonia, and Natolia, and are used in Austria and Germany for tanning and dyeing.

Knot. In Sea language, a geographical mile. It is also 120 times the distance between two knots on the log line. A knot is to a statute mile nearly as seven to six. [Log.]

Knots. The fastenings of ropes or cords; the union of ropes by interweaving. The most useful knots are: 1. *Thumb or over-hand knot,* tied at the end of a rope to prevent it from



opening out, &c.; 2. *Right or reef knot,* for securing all lashings where the ends of the rope meet together; 3. *Draw knot,* which offers great facility in undoing; 4. *Running knot,* used to bind or draw anything close; 5. *Sheepshank,* serving to shorten a rope without cutting it or unfastening the ends; 6. *Clove hitch,* which binds with excessive force, and by which alone a weight can be hung to a smooth pole; 7. *Timber hitch,* very useful in hauling to move a weight; 8. *Single bowline knot,* difficult to undo, useful to throw over a post, &c., to haul on, used for the draw-loop of a slip noose; 9. *Double bowline knot,* for slinging a cask; 10. *Running bowline knot*; 11. *Woolding* or *packing-stick hitch,* used to tighten ropes; 12. *Men's harness hitch,* passing over the shoulder and under the opposite arm of men drawing a carriage, &c.; 13. *Stopper hitch,* for stoppering the fall of a tackle, &c.; 14. *Inside clinch,* for fastening a cable to the anchor ring, &c.; 15. *Common or sheet bend,* a very secure method of joining two ropes, or fastening a rope to a loop; 16. *Hawser bend,* for joining two ropes, easily undone; 17. *Cat's paw,* the turn in the bight of a rope, for hooking a tackle to it; 18. *Drag rope or lever hitch,* used for fixing handspikes or capstan bars to the ropes attached to heavy carriages, &c., which have to be moved by men; 19. *Half hitch,* cast on the bight of a rope; 20. *Carrick bend.* A wall-knot is a knot made at the end of a rope to prevent it from passing through a hole.

A special committee of the Alpine Club report, on the subject of knots: 'There can be no doubt that every knot in a rope weakens its power of resisting a sudden jerking strain. . . . These ropes, which we report will resist the strain of fourteen stone falling eight feet, will not resist it if there is a knot in any one of them, or even if the knots used in attaching them to the point of support or to the weights be roughly or carelessly made. . . . We therefore conclude that: 1st. No knot which is not absolutely necessary ought to be allowed to remain on the rope; 2nd. The tighter and harder a knot becomes, the worse it is; 3rd. The more loose and open a knot is made, the better it is.' See *Alpine Journal,* No. 7, September 1864, where diagrams are given of the knots recommended by the above-named special committee.

Knout, The. An instrument used in the infliction of a well-known Russian punishment.

Koala. The native name of a Marsupial quadruped of New Holland. [Phascolarctos.] The Mahrattas apply the same name to the jackal.

Kobellite. A mineral resembling Antimony Glance in general appearance, but with a brighter lustre and a radiated structure. It is a sulpho-bismuthate of lead, in which part of the lead is replaced by iron and copper. It is found in the cobalt mine of Hvena in Sweden, and is named after Von Kobell.

Kobold. A German word signifying a spirit or spectre, and corresponding to the English *goblin,* of which it is probably the origin. In some parts of Germany there is scarcely a house or a family to which kobolds are not said to be attached; and according to the super-

stitious notions of the peasantry, they preside over all domestic operations, many of which they perform. The name of the metal *cobalt* is derived from the above.

Koff. A small two-masted vessel, formerly employed in the Dutch fisheries. It had two masts, main and fore, with a large spritsail abaft each. This arrangement enabled her to sail very close to the wind, and she could set squaresails if the wind happened to be astern.

Kokoona (Cing. kokoon). A large forest tree of the order *Hippocrateaceæ*, native of Ceylon. The yellow corky bark is used by the Cinghalese in the preparation of a cephalic snuff; and a lamp oil is expressed from the seeds.

Kola Nut. Kola, Gola, Guro or Goro Nuts are the seeds of the *Cola acuminata*. They are largely used as food and medicine by the natives of West Central Africa, and are highly valued, commercially, socially, and even politically. From the researches of Drs. Daniell and Attfield (*Pharmaceutical Journal*, March 1865) it would seem that their virtues must be ascribed to the presence of about two per cent. of *theine*, a substance existing also in tea, coffee, guarana, and matè, from one or other of which, beverages are prepared by Europeans, Americans, and Asiatics. Kola, like the substances just mentioned, has long been known to produce sleeplessness when eaten. It is curious and interesting to find that in all quarters of the globe man's instinct has induced him to select for the preparation of beverages, plants which differ greatly in appearance, characters, and habits, but which contain the same active principle.

Kolpodes, Kolpoda (Gr. κολπώδης). The name of a genus of Polygastric Infusories, characterised by their flat and sinuous figure.

Komenic Acid. [COMENIC ACID.]

Königite. A variety of Brochantite of a transparent emerald or blackish green colour, found at Katherinenburg in Siberia. It was named after König, late keeper of the minerals in the British Museum.

Könleinite. A fossil resin, found in the Brown Coal of Uznach in Switzerland and near Redwitz in Bavaria.

Koran. [ALCORAN.]

Koreïte. A hydrous Labradorite, found at Nagyag in Transylvania, and in China. The name Koreïte is applied by Dufrenoy to Agalmatolite.

Kosso, Kousso, or **Cusso.** The *Brayera anthelmintica*, an Abyssinian vermifuge. [BRAYERA.]

Kotschubite. A mineral of a carmine-red colour, discovered in the gold-washings of Karadinsk in the Ural. Named after Von Kotschuby, the Russian mineralogist.

Köttigite. A native arsenate of zinc, containing cobalt and nickel, and a trace of lime, from the Cobalt Mine Daniel, near Schneeberg in Saxony. Named after its discoverer, Köttig.

Koumiss. A vinous liquid, obtained in Tartary by fermenting the whey of mare's milk.

Koupholite (Gr. κοῦφος, *light*, and λίθος, *a stone*). A species of zeolite or Prehnite from the Pyrenees: it occurs in small rhomboidal plates, with a pearly lustre, and of a yellowish green colour.

Kraal. The Zulu name for a village.

Kraken (Ger.). A name applied to a fabulous marine monster of gigantic size.

Krameria (after the Kramers, German botanists). An anomalous genus, allied on the one hand to *Leguminosæ*, and on the other to *Polygalaceæ*, with which latter it is most frequently associated, or made a distinct family under the name of *Krameriaceæ*. They are branching undershrubs, with simple or trifoliate leaves, and racemose flowers. *K. triandra*, one of the simple-leaved species, is thought to have yielded the Rhatany roots formerly obtained from Peru, though all the species have probably similar astringent properties. Mr. Hanbury has recently shown (*Pharm. Journ.* 2 ser. vi. 461) that a very excellent form of Rhatany known as Savanella Rhatany, which has to a great extent superseded the former, and which is imported from New Grenada, is produced by a variety of *K. Ixina* to which the name of *granatensis* has been given. Rhatany is considered as a useful astringent medicine.

Krameric Acid. An acid obtained from the root of the *Krameria triandra*, or rhatany.

Krantzite. A fossil resin, occurring in the Brown Coal of Lattorf near Bernsberg. Named after Dr. Krantz of Bonn.

Kraut, Sour. [SAUER KRAUT.]

Kreasote (a word coined from Gr. κρέας, *flesh*, and σώζω, *I preserve*). Kreasote seems to be the principal source of the peculiar odour and of the antiseptic and preservative qualities of wood-smoke. When properly purified, it is a colourless oily-looking liquid of great refractive and dispersive power, of a penetrating smoky odour and a burning taste: its sp. gr. is about 1·04; it remains fluid at 17°; it burns with a sooty flame; is sparingly soluble in water, and is neutral to test paper. It dissolves readily in alcohol, ether, benzole, and acetic acid; and forms a crystalline compound with potash. It coagulates albumen; and a solution of it, containing not more than 1 per cent., preserves meat from putrefaction. The efficacy of crude pyroligneous acid as a preservative of provisions, and the peculiar smoky flavour which it confers upon them, appear to be due to kreasote. It is an irritant poison when undiluted, but when largely diluted it has been found effectual in checking vomiting, and as an application in toothache for the destruction of the nerve. It appears to be closely related to phenic (carbolic) acid, and the formula $C_{16}H_{10}O_2$ has been assigned to it.

Kreatine (Gr. κρέας, *flesh*). A crystallisable organic substance contained in the juice of the muscular flesh of animals. The term *kreatinine* has been applied to a product of its decomposition. Kreatine is represented as $C_8H_9O_4N_3 + HO$, and kreatinine as $C_8H_7O_2N_3$.

Kreittonite. A black variety of Automolite (Zinc-Spinel) found at Bodenmais in Bavaria.

Kremersite. A native chloride of potassium allied to Sylvine, and met with in ruby-red octahedrons at Vesuvius. Named after Kremers, by whom it was analysed.

Kremnitz White. A pure variety of *White Lead*, or Carbonate of Lead. [WHITE LEAD.]

Krishna. In Hindu Mythology, a divine being, produced from one of the hairs of Vishnu, and in his turn producing Brahma or Rudra the destroyer. (Muir, *Sanskrit Texts*, ch. ii. sec. 5; Godfrey Higgins, *Anacalypsis*.)

Krisuvigite. A variety of Brochantite, found at Krisuvig in Iceland.

Krokidolite. [CROCIDOLITE.]

Kronos. [ZEUS.]

Krum Horn. An old musical instrument, resembling a cornet. The name has been corrupted by organ-builders into that of the cremona stop of the organ.

Kryolite. [CRYOLITE.]

Krystalline (Gr. κρύσταλλος, *clear ice, crystal*). A term applied by Unverdorben to a salifiable base which forms crystallisable compounds with the acids, and which he obtained from animal empyreumatic oil. [ANILINE.]

Kshatriya or **Cshatriya.** [CASTE.]

Kufic. An epithet given to the ancient Arabic characters; from Kufa, a town on the Euphrates.

Kühnite. A native arsenate of lime and magnesia found in dirty-white or honey-yellow masses with a waxy lustre, at Longbanshyttan in Sweden. Named after Kühn, by whom it was analysed.

Kumbekephalic (a word coined from the Gr. κύμβη, *a bowl*, and κεφαλή, *the head*). Some of the early long-headed or dolichokephalic inhabitants of Scotland had a peculiar lengthened skull, in which the occipital bones were slightly elevated, whilst a depression extended along the parietals. This configuration has received the name kumbekephalic from Prof. Wilson. Many skulls of existing races exhibit this character.

Kunkur. A very peculiar deposit widely spread over the peninsula of India, and apparently corresponding in age and in the circumstances of its accumulation with the *drift* of England. It is a compact nodular calcareous clay with many concretions and very few fossils. It is found at all levels up to 3,000 feet above the sea. It is not generally stratified, and varies a good deal in different localities. In composition it is chiefly calcareous, containing about 70 per cent. of carbonate of lime, 15 per cent. of silica, and nearly 20 per cent. of alumina.

Kupaphrite (Lat. cuprum, *copper*, and Gr. ἀφρός, *froth*). Copper Froth. [TYROLITE.]

Kupfer Diaspore or **Copper Diaspore.** A variety of Phosphocalcite, with half an equivalent less water, the composition being, according to the following analysis by Kühn:—

Phosphoric acid	24·13
Oxide of copper	69·61
Water or loss .	6·20
	99·94

Kupfer Nickel. A term applied by the German miners to a native alloy of nickel and arsenic.

Kupfer Schiefer (Ger.). A series of schistose beds, often bituminous and very fossiliferous, lying near the base of the magnesian limestone or Permian series of deposits in Germany. The beds thus named are worked at Mansfeld in Thuringia for a singular deposit of argentiferous copper, which is mixed up mechanically with the shale and sand, forming a small percentage of the rock. The beds have long been worked, and are not unimportant in an economic sense.

Kupferblende or **Copper Blende.** Tennantite, with part of the iron replaced by zinc; from near Freiberg in Saxony.

Kupferblüthe. [CHALCOTRICHITE.]

Kupferpecherz. An impure variety of Chrysocolla, containing a large amount of Brown Iron-ore, found at Tourinsk in the Ural, and at the Basin of Mines in Nova Scotia.

Kurrajong. A native Australian name for several fibre-yielding plants, as *Hibiscus heterophyllus*, *Plagianthus sidoides*, *Commersonia platyphylla*, &c.

Kuteera or **Kutera.** A kind of gum obtained from *Cochlospermum Gossypium*.

Kyanise (named after Kyan, the inventor of the process). A mode of preserving timber from decay, by charging it with a solution of corrosive sublimate. [DRY ROT.]

Kyanite (Gr. κυανός, *dark blue*). A blue silicate of alumina, occurring massive and in prismatic crystals. It is the *Disthene* of Haüy, and the Sappare of some mineralogists. [CYANITE.]

Kymatin. A variety of Asbestos found at Kuhnsdorff in Saxony.

Kypholite (Gr. κυφός, *bent*, and λίθος, *a stone*). A variety of Serpentine.

Kyriological (Gr. κυριολογικός, *describing literally*). A term applied by Warburton, in his *Divine Legation* (book ii. s. 4), to that class of Egyptian hieroglyphics in which a part is conventionally put to represent a whole—e.g. a pair of armed hands for a battle, a scaling ladder for a siege, &c.; distinguished from the *tropical*, in which visible objects are used as emblems, or figuratively. [HIEROGLYPHICS.]

Kyrosite. A variety of White Iron Pyrites or Marcasite, containing arsenic and copper, which is found at the Briccius Mine, near Annaberg in Saxony, and also in Chili.

L

The first of the letters, in the English and most other alphabets, called *liquids* or *semi-vowels*, because, like vowels, they can be pronounced for any length of time, which is not the case with the consonants called *mutes*, as *p*, *d*, &c. It is the same as the Greek lambda, and the Hebrew or Phœnician lamed, and is found in the languages of almost all nations, excepting those of some Brazilian and Japanese tribes. In the ancient Greek, Hebrew, Phœnician, Celtic and Latin languages, and in those derived from them, the letter L consists invariably of two strokes, though in every possible shape and combination. Thus, in the most ancient Greek alphabets it is written ΛVΛ, in the Celtic <V, in Hebrew ל, and in Latin L. L, as an abbreviature, stands for Lucius, LL.D. Doctor of Laws, and LL.S. for a sestertium. As a numeral, L represented among the ancients, as at present, the number 50, according to the line—

Quinquies L denos numero designat habendos.

La. In Music, the syllable by which Guido denoted the last sound in the hexachord. It is now used by the French as synonymous with our note A.

Labadists. A sect of religious enthusiasts in the seventeenth century; so called from Jean Labadie, a native of France domiciled in Holland, who was deposed from his preachership by the synod of Dort. They endeavoured to introduce among Protestants similar notions to those of the Quietists in the Roman Catholic church, and were accused of similar perversities in practice. [Quietists.]

Labarraque's Disinfecting Liquid. A solution of carbonate of soda impregnated with chlorine.

Labarum. The standard of Constantine, which he caused to be formed in commemoration of the alleged vision of the cross in the heavens. It is described as a long pike surmounted by a golden crown inclosing a monogram which contains the first two letters of the name of Christ, and is at the same time a representation of the figure of the cross. Ancient monuments exhibit the figure under two forms, ⳩ or ☧ (sc. χ, ρ). The silken banner which depended from it was embroidered with the figure of Constantine and his family. The labarum is engraved on some of his medals with the famous inscription,

ΕΝ ΤΟΥΤΩΙ ΝΙΚΑ;

and it was preserved for a considerable time, and brought forward at the head of the imperial armies on important occasions, as the palladium or safeguard of the empire. The origin of the word is still undecided. (Beugnot, *Hist. de la Destruction du Paganisme en Occident* i. 57; Milman, *Hist. of Christianity* ii. 152.)

Labdanum. The resin of the *Cistus creticus* and some allied species. [Ladanum.]

Label or **Labellum** (Lat. dim. of labium, *a lip*). The third of the inner petals of an orchid, usually quite unlike the others in form, and turned towards the lower side of the flower. The name is also applied to a similar petal in other flowers.

Label. In Heraldry, a figure used chiefly by way of distinction or difference in the coat-armour of an eldest son during the life of the father. In this case it has three points; five points when borne by the heir-presumptive of a grandfather living, and so forth.

Labials (Lat. labium, *a lip*). The letters B, P, V, F, M, are so called, on account of the organ chiefly employed in their pronunciation.

Labiatæ (Lat. labium, *a lip*). A natural order of monopetalous Exogenous plants of Lindley's Echial alliance, consisting of many hundred species, inhabiting the more temperate regions of the earth. A two-lipped monopetalous corolla, an irregular number of stamens, and a four-lobed ovary, are the essential marks by which it is known from all others. The species are generally herbaceous, with square stems; a small number only consists of shrubs. The flowers are of all colours, but pure blue is uncommon in the order. Many of the species are valued for their fragrance, as Lavender and Thyme; others for their stimulating qualities, as Mint and Peppermint; some as aromatics, as Sage, Basil, and Marjoram; while a few are regarded as febrifuges. Numerous species are objects of great beauty, on which account the order is well known in gardens. Among the most ornamental are various kinds of *Salvia*, *Gardoquia*, *Dracocephalum*, &c. The order has sometimes been called *Lamiaceæ*, from *Lamium*, one of the genera.

Labium (Lat. *a lip*). In Entomology, a movable organ, often biarticulate, which, terminating the face anteriorly, covers the mouth from beneath, and represents the under lip. [Labrum.]

Lablab (the Arabic name of the Convolvulus). A genus of *Leguminosæ* yielding some of the kinds of tropical pulse. *L. vulgaris* and *cultratus* are much cultivated, the young pods being used like kidney beans, while the seeds or pulse are both wholesome and nutritious. Some varieties are better flavoured than others. The pods are flat, and marked along the edges with rough wart-like tubercles.

Labour (Lat. labor). In Political Economy every exertion, muscular or nervous, which is undertaken not for its own sake, but for some purpose of ulterior advantage, and with a view to its appraisement by some measure of value. Many occupations may be

very exhausting, and involve much physical or mental exertion; but if they are satisfied in themselves, and reflect solely on some immediate end, they have no direct economical significance. The labour of an amateur in a game of cricket may be very great, but it has no economical meaning; that of a professional cricketer, who is paid for his time and skill, has a meaning, because it has a market value. The toil of purely scientific observation may be great and unremitting, its results may be of signal benefit to mankind, but it is not economically appraised. But if the same labour is devoted to such ends as are susceptible of pecuniary compensation or material advantage to the student or observer, they fall within the definition of labour. Nor is it necessary, as some economists have suggested, that the exertion should be repulsive, disagreeable, or compulsory. It is quite possible that economical labour may be as agreeable to the worker, as any satisfaction felt in the mere pursuit of pleasure. It is conceivable that advantage and enjoyment should coexist in most occupations. For instance, the discovery of agricultural improvements, in the use of new manures, in the adaptation of machinery, in the trial of new seeds, and in crossing of seeds, may give as much pleasure as profit to the experimenter. The limitation often put upon labour, to the effect that it should be more or less disagreeable, is not an economical, but an ethical consideration, and one that is of by no means universal application.

The expression *unproductive labour* is also ambiguous and misleading, even though it has been sanctioned by the high authority of Adam Smith and many of his successors. It may be used of society collectively; it may apply to the result of individual exertion, and have a primary reference to the satisfaction of an individual's work. In relation to society, its significance is exceedingly vague, unless we are to consider that labour only as productive which is relative to the production of the lowest necessaries of life, and to no means of comfort, enjoyment, or elegance. If, however, we may say that human exertions are stimulated by the desire of procuring the largest amount of advantage by the least possible expenditure of force, and that such an impulse is the key to all economical progress, it would be idle to exclude from the class of productive labourers any whose avocations are not degrading, vicious, mischievous, or criminal. Nor is it likely, unless any artificial regulations of society favour particular classes or particular interests, that such callings as those which minister to what are called luxury or enjoyment will ever be excessive or dangerous. All distinct enactments or privileges hindering the distribution of wealth have indeed a tendency towards developing those kinds of occupation which are relative to exaggerated and extravagant expenditure, but they also cripple the just progress of society, and often call into existence classes of persons whose business is to supply those very vicious and mischievous tastes which are ruinous to the individuals in whose favour the privilege was created. But labour may be unproductive to the individual, i.e. he may fail to secure the advantage which he has proposed to himself, and he may have wasted his capital and exertion. Errors as to the market or saleable value of any commodity or service are no doubt of frequent occurrence, and often entail much individual loss; but in a state of progressive wealth they are far counterbalanced by labour which has achieved its purpose, and which adds to individual advantage and collective prosperity.

Economists, too, have been apt to give an artificial limitation to the word *labour*, by confining it to such exertions as are almost or nearly mechanical. But the term *labour* is as fully applicable to the services of a statesman as it is to the functions of a ploughman or a spinner, and both in the main are as much undertaken for the sake of prospective remuneration. On this point Adam Smith is abundantly distinct. Dividing as he does the distribution of the gross product of labour into wages, profit, and rent, he continually shows that wages are disguised under the name of *profit*, and implies that by profit he intends to mean only that remuneration of capital which is relative to and fixed by the current interest on advances. It is true that the term *wages* is generally limited to that method of payment in which the capitalist remunerates a portion of the labour expended on the article in which he trades; but the distinction between wages and that portion of his profits which he appropriates as the reward of his own energies, skill, and superintendence, is merely an error of popular language, and one which, if uncorrected, tends to serious inconvenience in the interpretation of various social and fiscal expedients. It is hardly necessary to say, that by far the largest portion of national income is the product of labour, and that this product is continually increased by the substitution of mechanical forces for the mere muscular labour of man. It is also clear that the margin on which taxation can operate can be that only which is beyond the necessary subsistence of the labourer, his security against ordinary contingencies, and what is needed for the replacement of capital.

Labour is, economically speaking, set in motion by capital; in other words, the labour must be called into existence, and supplied with the means of subsistence during the time in which production goes on, and up to the period at which the produce of labour is exchanged. Hence, however abundant labour may be, and however urgent the demand for the produce of labour, no product will be forthcoming unless capital be supplied by which labour may be set in motion. The excessive demand for cotton wool which has characterised the cotton manufacture during the last four years has only been very partially supplied. The area over which cotton can be cultivated contains, perhaps, a wider geographical range than the limits assigned to any other botanical production, and the labour available for its culture is amply

sufficient for a quantity far in excess of any demand hitherto existent. The crop, too, is in several species of cotton derived from an annual. But, as is well known, the manufacture of cotton goods has been almost paralysed by a sudden deficiency in the customary supply. The reason, however, why the demand has not been satisfied, is due to the fact, that the capital necessary to stimulate the labour has been wanting. [PROFIT; MANUFACTURE; TRADES' UNION; WAGES.]

Labour Rents. In the rudest states of society, as in the most civilised, the wealthier and the more influential classes are sustained by the possession of land, a portion of the produce of which they secure to themselves by the fact of appropriation, and by allowing the privilege of labour upon the surface to the cultivator of the soil. When capital is scanty and the union of society feeble, the lord of the soil has been accustomed, in all those parts of the world in which agricultural pursuits prevail, to grant portions of the land which he possesses, to be held either on permanent or precarious tenure by his dependants, on the condition that they contribute a portion of their labour to cultivating that which he retains. Such was the tenure of villenage in England, during the prevalence of the feudal system, a tenure gradually extinguished, or rather substituted by copyholds, in consequence of the gradual exchange of prædial services for fixed money payments. [MANOR.] Such was till lately the serf system in Russia; such is practically the ryot system in many parts of British India.

Labour rents were in their first institution a necessary process for the maintenance of an upper or governing class. In England it is not too much to say that in very early times labour rents, or pecuniary compensations in the place of such rents, formed the chief revenues of the feudal barons. But it will be obvious that they are never satisfactory. The labour which is compulsory can never be heartily given, and will always be wasteful and dear. Hence a reform in such a tenure is inevitable, when a community makes any notable advance in civilisation and wealth. There can be little doubt that one of the chief causes which contributed to the great political influence of this country in the middle ages, is to be found in the fact of its having been early able to commute labour rents for fixed money payments, and so to secure a free and improving body of yeomen.

Labourers, Statutes of. Towards the close of the first half of the fourteenth century, a plague of novel and excessive virulence sprang up in the farthest recesses of Eastern Asia. It appears to have travelled very slowly towards Europe; for if the chronological statements of the age can be depended on, it took nearly ten years for this visitation to pass from China to Western Europe. When it did reach Europe, its ravages were fearful. After every allowance being made for exaggeration, seems difficult to doubt that it destroyed nearly half the inhabitants. Called at first the Black Death, it has survived as an endemic to our own times under the name of the Turkey, Levant, or Egyptian plague. It forms the background to Boccaccio's *Decameron*, and it is said that, like that of the Athenian plague, its incidence was accompanied by an excessive licentiousness and depravity of manners. The last notable visit of this pestilence to this country occurred in the great plague of London. Its ravages, though not confined to the lower orders, were nevertheless most destructive among the poor; and this for the very obvious reason, that sanitary conditions were wholly unknown to our forefathers, and that the quarantine regulations of the time, under a show of precaution, in reality secured hotbeds for the preservation and spread of infection.

It has been observed, that there is reason to believe the statement that half the working population was destroyed. The immediate effect of the plague was that the rate of wages was, on the whole, doubled in consequence of the scarcity of hands. For instance, while the rate of threshing wheat had stood on an average at *5d.* the quarter, it instantly rose to *10d.* or *1s.*, and similarly with other piecework. Daywork also, and all materials, the value of which depends largely upon the labour expended in producing them, as iron and cloth, rose in proportionate rates: the profit on agricultural operations, a considerable portion of the landholder's estate being at that time cultivated for him by a bailiff, fell to a minimum, and the owners of land were threatened with a very large deduction from their customary incomes. The time also, that of the wars between England and France, was one of heavy taxation on personal property, and of continual military service. Hence the aid of parliament was invoked, in order to fix the rate of wages; and the first statute regulating the price of labour was enacted in 1350. The statute fixing the rate of wages was accompanied by others limiting the price of the necessaries of life. Both enactments were absurd, but the latter in a much higher degree than the former. From this time forward, the legislature has attempted to regulate, in various ways, the prices of labour; in earlier times by fixing the rate in parliament, in later by ordaining that the justices of peace in the several counties should meet and determine wages for each current year. Coordinate with these limitations were those which provided against the combinations of labourers, with a view to increase the rate of wages. All these laws were finally repealed in 1826, but they have left a heritage in the reactionary remedy of trades' unions.

Labrador Felspar. Labradorite. A variety of Felspar originally brought from the coast of Labrador. When viewed in certain directions it exhibits a beautiful play of colours; and the mutable opalescent tints of blue, red, green and yellow, which are reflected from the

surface, vary according to the position in which the stone is viewed, so that the same spot exhibits various tints if held in different positions, violet and red being the most rare. It takes a fine polish, and when cut into thin slabs it is employed in jewellery and for other ornamental purposes.

Labrax. A genus of Percoid fishes, dismembered by Cuvier from the Linnæan *Perca* on account of certain modifications of the gill-covers and tongue; the differences being that the opercula of the *Labrax* terminates in two spines, and the tongue, instead of being smooth, is roughened with many minute teeth.

Labridans, Labridæ, or Labroides. The Bream tribe. A family of Acanthopterygii, having the genus *Labrus* as the type. The fishes of this family may be recognised by their oblong scaly body; a single dorsal fin, supported in front by spines, each of which is generally furnished with membranous appendages. The jaws are covered with fleshy lips, and the pharyngeal bones are armed with numerous and strong teeth, disposed like a pavement. [BREAM.]

Labrum (Lat.). In Entomology, the usually movable part which, terminating the face anteriorly, covers the mouth from above, and represents the upper lip. [LABIUM.]

Labrus (Lat.). A genus of spiny-finned fishes in the system of Cuvier, with well developed double fleshy lips. The fishes of this genus are termed *bream*; and are further characterised by their conical maxillary teeth, of which the middle and anterior are the longest, and by their cylindrical and obtuse pharyngeal teeth, which are arranged like a pavement—the upper ones on two large plates, the lower ones on a single one, which correspond with the two others.

Laburnum. The common name of an ornamental early-flowering tree of the Leguminous order, the *Cytisus Laburnum* of botanists. Every part of this common ornamental tree is poisonous, especially the bark and seeds. A curious case of poisoning by it is reported by Dr. Christison in the *Edinburgh Medical Journal* for October 1843, and Dr. Taylor (*On Poisons*) has cited several others. The symptoms are vomiting, purging, and prostration. The term *Cytisin* has been applied to the poisonous principle.

Labyrinth (Gr. λαβύρινθος). Literally, a place, usually subterraneous, full of inextricable windings. Ancient mythology and history give an account of four celebrated labyrinths; the Cretan, Egyptian, Lemnian, and Etruscan. The first, wholly mythical, is said to have been built by Dædalus at the instigation of Minos, to secure the Minotaur. The second, said to have been constructed by Psammetichus, king of Egypt, was built on the isle of Meroe, and was a vast edifice, composed of twelve palaces, all contained within the compass of one wall, and communicating with each other. It had only one entrance; but the innumerable turnings and windings of the terraces and rooms of which it consisted, rendered it, it is said, impossible for those who had once entered within its walls to get out without a guide. It is supposed to have been designed either as a burial-place for the Egyptian kings, or for the preservation of the sacred crocodiles, the chief objects of Egyptian idolatry. It was partly demolished between the reigns of Augustus and Titus; but even at the period of Pliny's visit, its ruins were magnificent. (Pliny, lib. xxxv.) Pococke's *History of the East*, vol. i. p. 61 &c., and Perry's *View of the Levant*, p. 381, contain a plan and description of the modern state of this labyrinth. There is no evidence of any such building in Crete; the existence of intricate caverns may possibly account for the myth. The labyrinth of Porsenna, as described by Varro, is clearly fictitious.

LABYRINTH. A term applied by anatomists to certain internal parts of the ear, from the intricacy of their winding passages. [EAR.]

LABYRINTH. In Metallurgy, a series of troughs attached to a stamping mill, through which a current of water passes for the purpose of washing away the suspended pulverised ore, and subsequently depositing it at different distances, depending upon its state of comminution.

Labyrinthodonts (Gr. λαβύρινθος, and ὀδούς, *tooth*). An order of fossil reptiles, in which the head was defended, as in the *Ganocephala*, by a continuous casque of externally sculptured and unusually hard and polished osseous plates, including the supplementary *postorbital* and *supratemporal* bones, but leaving a *foramen parietale.* Two occipital condyles; vomer divided and dentigerous; two nostrils; vertebral bodies, as well as arches, ossified, biconcave; pleurapophyses of the trunk, long and bent; teeth rendered conflex by undulation and side branches of the converging folds of cement, whence the name of the order. This group, which is found in the carboniferous strata (*Baphetes*), is otherwise restricted to the carboniferous period. The genera *Baphetes*, *Labyrinthodon*, *Rhombopholis*, *Mastodonsaurus*, *Trematosaurus*, *Metopias*, *Capitosaurus*, *Zygosaurus*, *Odontosaurus*, and *Xestorrhytias*, belong to this order.

Lac (Lat.; Gr. γάλα, γάλακτος, *milk*). A resinous substance which in India flows from certain trees, in the form of lucid tears, in consequence of punctures made upon their branches by a small insect, the *Coccus ficus*. The *Ficus indica*, and *F. religiosa*, *Butea frondosa*, *Zizyphus Jujuba*, and according to Dr. Hooker a species of *Celtis*, are amongst those which produce it. Dr. Hooker adds: 'The elaboration of this dye, whether by the same species of insect or by many, from plants so widely different in habit and character, is a very curious fact, since none have red juice.'

The commercial varieties of Lac are: *stick lac*, which is the substance in its natural state, investing the small twigs of the tree; *seed lac*, which is the same, broken off from the twigs, and which when melted and formed into thin cakes con-

stitutes *shell lac.* These varieties of lac have been examined by Mr. Hatchett (*Phil. Trans.* 1804), with the following results:—

	Stick Lac	Seed Lac	Shell Lac
Resin . . .	68·0	88·5	90·9
Colouring matter.	10·0	2·5	0·5
Wax . . .	6·0	4·5	4·0
Gluten . . .	5·5	2·0	2·8
Foreign bodies .	6·5	—	—
Loss . . .	4·0	2·5	1·8
	100·0	100·0	100·0

The great consumption of lac is in the manufacture of dye stuffs, sealing wax, and of certain varnishes and *lacquers.*

LAC. In Commerce, a word used in the East Indies, to denote the sum of 100,000 rupees, or 12,000*l.* sterling. One hundred lacs, or 10,000,000 rupees, make a *crore.*

Lac Dye, Lac Lake. These are two preparations of lac imported in small cubic cakes from the East Indies, and extensively used in the production of scarlet dye. They are said to be prepared by digesting seed lac in an alkaline solution, which produces a deep pink liquid, the colouring matter of which is thrown down in combination with alumina by the addition of a solution of alum. The colouring matter of these dyes much resembles that of cochineal, for which it is largely substituted. In dyeing scarlets the liquid used for dissolving the colour is a solution of tin in hydrochloric acid, and tartar and sumach are used as mordants.

Laccic Acid. A peculiar acid said by Dr. John to exist in some varieties of seed lac. It is yellow, crystallisable; and forms soluble salts with potassa, soda, and lime, and insoluble salts with the oxides of mercury and lead. It occasions no precipitate in solution of baryta or of oxide of silver.

Laccine. A substance discovered in shell lac by Unverdorben. It remains after all the soluble matters in water, alcohol, and ether have been extracted. It is brittle, yellow, translucent; and soluble in caustic potash, and in sulphuric acid.

Lace (Ital. laccio, Lat. laqueus, *a lace* or *noose*). An ornamental fabric of linen or cotton thread, formerly made by hand (when it was called *pillow* or *bone* lace), but of late years produced by machinery, and generally termed *bobbin-net.* 'This manufacture,' says Dr. Ure, 'may be said to surpass every other branch of human industry in the complex ingenuity of its machinery; one of Fisher's spotting frames being as much beyond the most curious chronometer in the multiplicity of mechanical device, as that is beyond a common roasting jack.'

The costly and complicated machines by means of which bobbin-net is produced are termed *lace frames.* A *rack of lace* is a certain number of meshes counted perpendicularly, and contains 240 meshes or holes; and such has already been the improvement in this manufacture, that the cost of labour in making a *rack*, which was twenty years ago 3*s.* 6*d.*, is now reduced to 1*d.* Formerly the wholesale price of a 24-rack piece, five quarters broad, was 17*l.* sterling; the same is now sold for 7*s.* In the *Commercial Dictionary* will be found full statistical details of the value of the lace manufacture in this country, together with a learned and curious account of the origin and history of the fabric.

Lace-bark. [LAGETTA.]

Lace-leaf. [OUVIRANDRA.]

Lacerna (Lat.). A long woollen military cloak, worn at first only by the Roman soldiers, but which increased so much in fashion that at the period of the triumvirate it became a favourite piece of dress with all the higher classes of Roman citizens, both civil and military, and remained so till the times of the emperors Valentinian and Theodosius, when the senators were prohibited from wearing them in the city. Martial speaks of lacernæ which cost 10,000 sesterces (80*l.*).

Lacerta (Lat.). The *Lizard*; a constellation of the northern hemisphere, near Cepheus and Cassiopeia, formed by Hevelius.

Lacertidæ (Lat. lacerta, *a lizard*). A group of the order *Sauria*, forming the second family in the Cuvierian system, in which the characters are given as follows: Tongue long, slender, extensible, and bifurcate at the extremity, as in the serpent tribe; ear-drum membranous, on a level with the surface of the head or very slightly sunk; eyelids consisting of a production of the skin, with a longitudinal slit, closed by a sphincter, and a rudimental nictitating or third eyelid; body elongated; feet with five toes each; digits separate and unequal, particularly the hind ones, all armed with nails; scales on the belly and round the tail arranged in transverse and parallel bands. Cuvier subdivides the *Lacertidæ* into the two great genera *Monitor* and *Lacerta*, each of which have been again subdivided.

Lachenalia (after De la Chenal). A genus of *Liliaceæ* from the Cape of Good Hope, consisting of bulbous plants, with spotted orchis-like leaves, and spikes of pendulous tubular flowers, often yellow. They are ornamental spring flowers for the greenhouse, but have no useful properties.

Laches (Fr. lache, *negligent*). In Law, slackness or negligence. A term used to signify that degree of negligence which throws on the party committing it the evil consequences resulting to him from it.

Lachesis. [FATES.]

Lacing. In Sea language, the rope used to fasten a sail to its yard or gaff; also the piece of timber intervening between the figure-head of a ship and the knee of the head.

Laciniate (Lat. lacinia, *a fringe*). In Botany, having the margin slashed into fringe-like segments.

Lacinula. In Botany, a term given to the abruptly inflexed acumen of each of the petals of an umbelliferous flower.

Lacistemaceæ (Lacistema, one of the genera). A natural order of hypogynous Exogens,

belonging to the Violal alliance, and distinguished by the amentaceous, scaly, apetalous, polygamous flowers, and unilateral stamens. The order comprises a few shrubs, found in the woods of equinoctial America.

Laconicum. A dry sudorific bath in a chamber heated with warm air by means of a stove. It was so called by the Romans as having been first introduced in Laconia.

Laconism. A short and pointed saying; so termed from the celebrity which the Lacedæmonians enjoyed for their brief and sententious mode of expressing themselves. There is an essay by Puteanus, *De Laconismo*.

Lacquer. A varnish, consisting of a solution of shell lac in alcohol, coloured by gamboge, saffron, annotto, or other yellow, orange, or red colouring matters. Lacquers are chiefly used for varnishing brass and some other metals, in order to give them a golden colour and preserve their lustre. The term *lacquer* is also applied to a mixture of Swedish pitch and coal tar, with which the inside of certain shells for rifled guns is coated, in order to prevent excessive friction between their interior surface and the bursting charge of powder during flight.

Lacrymal (Lat. lacryma, *a tear*). Relating to tears; as the *lacrymal glands*, by which they are secreted. They are placed in a depression of the frontal bone, above the external angle of the eye; the tears pass from them to the eye by the lacrymal ducts, which are six or eight in number.

Lacrymatory. A small vessel of glass or earthenware, which it was customary at Roman funerals to fill with the tears (*lacrymæ*) of the mourners, and deposit them with the ashes of the deceased in the sepulchre.

Lacteals (Lat. lac, *milk*). The absorbents of the mesentery, which convey the milky fluid called *chyle* from the small intestines to the thoracic ducts.

Lactic Acid. The acid of sour milk. It is formed in a variety of processes, and is a frequent product of the acidification of vegetable substances. It is best obtained by dissolving 8 parts of cane-sugar in 50 of water, to which one part of casein or of poor cheese and three parts of chalk are added. This mixture kept for two or three weeks at a temperature of 80° gradually forms crystals of lactate of lime, which after having been purified by recrystallisation may be decomposed by sulphuric acid. The residue digested in alcohol leaves sulphate of lime, and gives an alcoholic solution of lactic acid.

Pure lactic acid is an uncrystallisable liquid of a sharp acid taste, soluble in alcohol and in ether, and represented by the formula $C_{12}H_{10}O_{10},2HO$. By long exposure to a heat of 265°, it becomes anhydrous ($=C_{12}H_{10}O_{10}$). and in that state is nearly insoluble in cold water; but when boiled in water, it gradually reverts to the hydrated state.

Lactic acid is contained in the fluids of the muscular tissues, and occasionally in some of the excretions.

Lactine, Lactose. *Sugar of milk.* This important form of sugar is exclusively of animal origin, and is contained in the milk of the mammalia: it is secreted in greatest abundance by the herbivora, but also by the carnivora, though fed upon animal substances only. It is largely prepared in Switzerland, by the evaporation of whey, and crystallises upon sticks immersed in the concentrated liquid; it forms mammillated masses composed of four-sided prisms. Sugar of milk is white, sweetish, and gritty between the teeth; it requires about six parts of water for solution, and is insoluble in alcohol and in ether. When boiled in very dilute acids it slowly passes into glucose. Under the influence of caseine, which acts as a ferment, sugar of milk undergoes alcoholic fermentation; but in the spontaneous souring of milk, lactic acid is formed. Like the other sugars, lactine is a hydrate of carbon, represented by $C_{24}H_{24}O_{24}$. According to Regnault, in combining with oxide of lead it loses five atoms of water, so that the formula $C_{24}H_{19}O_{19}+5HO$ has been adopted. The homœopathists use sugar of milk as a vehicle for their remedies, objecting to common sugar on account of the traces of lime which it contains.

Lactometer (Lat. lac, and metrum, *a measure*). A term applied to a glass tube for ascertaining the proportion which the cream bears to the milk of any particular cow, or of the produce of a whole dairy. The tube is about half an inch in diameter, and a foot in height, with a graduated scale marked on the outside. It is filled with milk when newly drawn from the cow, and as it cools the cream rises to the surface, and the proportion which it bears to the milk is ascertained by counting the degrees opposite to each. Various other *lactometers* have been suggested, but none of them satisfactory in reference to the easy determination of the absolute quantity of cream (or butter) contained in various samples of milk.

Lactone. A pungent volatile liquid occurring among the products of the destructive distillation of lactic acid.

Lactuca (Lat. from lac, *milk*). To this genus of the Cichoraceous group of *Compositæ* belong the esculent *L. sativa* and the medicinal *L. virosa*. The former, which is the Garden Lettuce, is well known as one of the most agreeable and useful of salad plants. The narcotic and sedative principles which exist in lettuces do not occur except to an infinitesimal extent in the succulent young leaves that form salad; but when the flowering stem is thrown up, the sap becomes milky and bitter, and its narcotic properties are then more fully developed. The sedative effects of lettuces appear to have been known from the earliest times. The popular opinion respecting the properties of these plants is maintained in our own times by the doggrel—

for want of rest,
Lettuce and cowslip-wine *probatum est.*

Lactucarium. The inspissated milky juice of the *Lactuca sativa*, or common Garden Let-

tuce. It possesses slight anodyne properties, and is sometimes used as a substitute for opium.

Lactucic Acid. A peculiar acid, discovered by Pfaff in the juice of the *Lactuca virosa.* It bears some resemblance to oxalic acid; but differs from it in giving a green precipitate with the protosalts of iron, and a brown precipitate with sulphate of copper.

Lactucin. A bitter crystalline resin; the active principle of the wild Lettuce.

Lacuna (Lat.). In Botany, a term applied in describing lichens, to denote one of the small hollows or pits on the upper surface of the thallus. Also a name given occasionally to the internal organ, commonly called an air-cell, lying in the midst of the cellular tissue of plants.

Lacunar (Lat.). In Architecture, the ceiling, or the underside of the member of an order. Also the under side of the larmier or the corona of a cornice. The under side also of that part of the architrave between the capitals of the columns. The ceiling of any part in architecture receives the name of lacunar only when it consists of compartments sunk, or hollowed, without spaces, or bands between the panels; if it be with bands, it is called a *laquear.*

Lacunose (Lat. lacunosus, from lacuna, *a pit or cavity*). In Zoology, when a surface has a few scattered, irregular, broadish, but shallow excavations.

Lacustrine Deposits. By this name the geologist means such deposits as have evidently been formed at the bottom of pools of fresh water. The deposits of lakes differ from those of rivers, not merely in the fact that they are of finer material and slower accumulation, but that from the nature of the case there is a greater amount of chemical change connected with them, owing to the more regular and equable condition under which they have been formed. In large lakes there is generally at one part a delta of coarse rolled blocks and gravel where some river enters, but the floor of the lake is elsewhere coated with fine mud, slowly accumulating, and not unfrequently the floor is much influenced by organic causes, or by substances separated from chemical solution in the water; of the latter kind are deposits of salt, gypsum, and other minerals from the waters of salt lakes. Most of the well-known lake deposits are of tertiary date, but some older deposits of limestone near the coal measures and some marls may also be regarded as lacustrine. It not unfrequently happens that the ancient borders of lakes, known only by lacustrine deposits, may be traced with tolerable certainty in mountain districts. Marls are very common deposits in lakes, but the order of arrangement of the rocks is often very irregular. [AQUEOUS ROCKS and FRESHWATER DEPOSITS.]

Lacustrine Habitations. Under this name are described remains of human habitations of extreme antiquity, constructed by former inhabitants of Europe on certain lakes in Switzerland, Ireland, and elsewhere, and only recently brought into notice by archæologists and geologists.

The habitations in question formed villages, constructed entirely on piles in the waters of the lakes, and communicating with the shore by causeways or bridges, and also on piles which were often of great length. They were thus entirely safe from land attack. In most cases they have been destroyed by burning, and the charred piles are the best indications of the position of the villages. In the water amongst these piles has been found a rich variety of almost every kind of material used by the inhabitants. Fishing implements, fragments of boats, and various articles in stone and metal, might have been expected; but there are also remains of perishable objects, such as cloth, and even of loaves of bread reduced to cinder.

It is certain, from the evidence thus afforded, that there existed in various parts of Central and Western Europe races of men who had attained a certain degree of civilisation at a date long anterior to the most ancient local records. Who these were, whence they were derived, and how and when they became extinct, are problems yet unsolved. They preceded the existing races, but succeeded other peoples of whom we have records in the caves of England, France, and Belgium, and in the shell-heaps or *kitchen-middens* (Dan. kjökken-mödding) of the shores of Scandinavia and Scotland.

Ladanum (Lat.; Gr. λάδανον or λήδανον). A resin which exudes from the *Cistus creticus,* a shrub which grows, as its name implies, in Crete. In the time of Dioscorides it was collected by combing the beards of the goats which browse on the plants.

Ladder (A.-Sax. hlædre). The framing used in scaffolding to mount from one stage to another. Ladders are usually made of a tree split down the middle: the two halves are then placed about one foot apart, and are kept in their position by the *rounds* or *rings* which form the foothold; they are placed about one foot from centre to centre. In mines, the sides are made occasionally of wrought timbers, but sometimes of wrought iron.

LADDER. On Shipboard, a set of wooden steps affording access between the several decks. There are several in a large ship, distinguished in name by their purpose or by the part of the vessel in which they are situated; that leading down from the quarter-deck is the *companion ladder*; *accommodation ladder* is a temporary flight of steps placed against the outside planking of a ship to furnish an easy entrance from boats. *Ladder-ways* are the square openings cut in the decks for the insertion of the ladders.

Ladies' Slating. A size of slates, 16 inches long by 8 inches wide; 222 such slates are needed to cover one square of roofing.

Lady (A.-Sax. hlæfdige). This title properly belongs to the daughters of all peers above the rank of a viscount; and is extended, by courtesy, to the wives of knights of every degree. (For the origin of the word, see Max Müller, *Lectures on Language,* second series, p. 255.)

Lady-day. In the Calendar, the 25th of March, being the Annunciation of the Virgin Mary. It is one of the immovable festivals of the church, having relation to Christmas, or the day of the nativity of Christ, which it precedes by nine months.

Læmodipods (Gr. λαιμός, *throat*; πούς, *foot*). The name of an order of Crustaceans, in which the head is confluent with the first segment of the thorax, and supports the four anterior feet. The *Læmodipods* are the only Malacostracans with sessile eyes, and in which the posterior extremity of the body exhibits no distinct branchiæ. The females carry their ova beneath the second and third segments of the body in a pouch formed of approximated scales. All the species are marine.

Læstrygones (Gr. λαιστρυγόνες). In the Homeric Mythology, certain gigantic beings, represented as keepers of sheep, on the confines of day and night, and ruled by a king named Antiphates. (*Odyssey* x. 83.) [Cyclopes; Phæacians.]

Lævoracemic Acid. Racemic acid is a compound of two acids of the same composition, but having opposite effects on a ray of polarised light. One of these acids twists the ray to the right, and is hence called *dextro-racemic acid*; the ordinary tartaric acid of commerce is this substance. The other twists it to the left, and is therefore termed *lævo-racemic acid.*

Lævotartaric Acid. [Lævoracemic Acid.]

Lagan. [Flotsam.]

Lagenaria (Lat. lagena, *a bottle*). The Bottle or Club-shaped Gourds are names given to varieties of *L. vulgaris*. The genus belongs to the *Cucurbitaceæ*, and consists of annual pubescent herbs, with heart-shaped leaves, white monœcious flowers, and flask-shaped fruit, which when mature become woody pepos. They are found in the warm parts of Asia and Africa.

Lagetta (Lagetto, the native name). The Lace-bark tree of Jamaica is *L. lintearia*, the inner bark of which consists of numerous concentric layers of fibres, interlacing in all directions, and thus having a considerable resemblance to lace. The bark is made into bonnets, collars, and other articles of apparel, and was formerly made into thongs and whips for flogging negroes.

Lagging of the Tides. In Terrestrial Physics, a phenomenon of the tides, consisting in the irregularity of the lengths of the successive tide-days or intervals of the occurrence of high water at any particular place, and caused by the combined action of the sun and moon on the ocean. If the tides were caused by the moon's attraction only, the intervals between two successive arrivals at the same place of the same vertex of the tide-wave would be the lunar day, that is, the interval between two successive arrivals of the moon at the same meridian. In like manner, if the tides were caused by the sun's attraction only, the tide-day would be of the same length as the solar day. In consequence of the moon's revolution about the earth in the same direction as the diurnal rotation, the lunar day is longer than the solar; and the actual or lunisolar tide being the result of the superposition of the two tides caused by the sun and moon respectively, it follows that from the time of coincidence of these two tides the actual tide-day (reckoned in mean solar time) will become longer and longer, until the moon has completed a quarter of a revolution, after which the lunar wave will fall back on the next following solar wave, and the tide-day will become shorter and shorter during the next quarter of the moon's revolution, and the coincidence will again take place when a semi-revolution is completed. This alternate acceleration and retardation of the tidal intervals is called the *priming and lagging of the tides*, and is most remarkable about the time of new and full moon. [Tides.]

Laggings. The planking that forms the actual surface of a centre of an arch, and which is intended to receive the voussoirs. The term is also applied to the covering put round a cylinder of a steam-boiler, in order to prevent the radiation and the consequent waste of heat; the laggings are in these cases of wood, and they enclose a layer of felt or other non-conducting substance.

Lagomys (Gr. λαγώς, *a hare*; μῦς, *a mouse*). The generic name of certain Rodents, called *rat-hares*, now peculiar to Siberia. They differ from the hares proper in having moderate-sized ears, legs nearly equal, clavicles nearly perfect, and no tail. The fossil bones of a species of *Lagomys* have been discovered in the osseous breccia of Corsica and in England.

Lagonite. An earthy mineral of an ochreous yellow colour, found as an incrustation at the lagoons of Tuscany.

Lagoon (Lat. lacuna, *a pit or hole*). The name given particularly to those creeks along the coast of the Adriatic, which are formed by water running up in the land. In some places they are deep; but generally they are so shallow as to emit noxious exhalations. They contain many islands; on sixty of which the city of Venice is built. Towards the sea these islets are secured by dams, either natural or artificial.

Lagophthalmia (Gr. λαγώς, *a hare*, and ὀφθαλμός, *an eye*). A disease in which the eye cannot be closed. Sometimes it is a paralytic affection, but sometimes it depends upon enlargement of the eye; it is also occasionally connate. The term has reference to the notion that hares sleep with their eyes open.

Lagopus (Gr. λαγώς, *a hare*; πούς, *a foot*). The generic name of those birds of the grouse tribe which have a round or square tail, and whose toes are feathered as well as the legs.

Lagostoma (Gr. λαγώς, and στόμα, *the mouth*). The harelip.

Lagothrix (Gr. λαγώς; θρίξ, *hair*). A genus of South American or Platyrrhine monkeys, characterised by their round head, a thumb on the anterior hand (a characteristic which distinguishes them from *Ateles*), and the

tail partly naked. The grison, or silver-haired monkey, is a species of this genus.

Lagrange's Theorem. This theorem enables us to develope any function of y in a series according to x, when y is an implicit function of x and z in virtue of the given relation $y=z+x\,\phi\,(y)$. It is thus expressed:

$$F(y)=F(z)+F'(z).\phi(z).\frac{x}{1}$$

$$+\frac{d}{dz}\left\{F'(z).[\phi(z)]^2\right\}\frac{x^2}{1.2}+\&c.$$

$$+\frac{d_{n-1}}{dz^{n-1}}\left\{(F'z)[\phi(z)]^n\right\}\frac{x^n}{1.2\;...\;n}+...$$

This theorem was subsequently generalised by Laplace to embrace the case where

$$y=f\,[z+x\phi\,(y)].$$

To obtain Laplace's theorem it is merely necessary to replace, in Lagrange's, z by $f\,(z)$. Lagrange gave his theorem in the *Mém. de l'Acad. des Sciences* 1768; Laplace gave his in the *Mécanique Céleste.*

Lagrimoso (Ital.). In Music, a direction to the performer, when appended to a piece of music, denoting that it is to be performed in a weeping, plaintive manner.

Laird. A Scottish term, applied, as Libb remarks, to 'a landed gentleman under the degree of a knight;' it is regarded by many philologists as originally equivalent to Lord. Anciently the title of *laird* was given only to those proprietors who held immediately of the crown; and this distinction is still preserved in the Highlands. The designation *tiern*, corresponding to *laird* and rendered by it, is given to no one whose property is not worth two or three hundred per annum, while it may be withheld from a man whose rental extends to as many thousands; because the former acknowledges no superior under the king, while the latter does.

Laity (Gr. λαός, *people*). The great body of the people, as opposed to those who are set apart for the celebration of Divine worship —the clergy. This distinction is plainly observed in the writers of the third century— Origen, Cyprian, and Tertullian. The word *laity* is properly a general name for the people: in the writings of the Fathers βιωτικοί, *seculars*, ἰδιῶται, *private men*, and λαικοί, *laymen*, are used indifferently to express this class.

Lake. A compound of alumina with the red colouring matter of certain animal and vegetable substances. Sometimes the term *lake* is indiscriminately applied to all compounds of alumina and colouring matter.

Lake Dwellings. [Lacustrine Habitations.]

Lakes (Lat. lacus). Sheets of water occupying depressions on that part of the surface of the earth not covered by the waters of the ocean. Lakes differ from inland seas in not communicating with the ocean except by a river. They differ from pools and ponds not only in being larger, but in having definite banks and permanent limits.

Lakes occur at all levels, from that of the Dead Sea, nearly 1,400 feet below the ocean, to that of Titicaca, 1,300 feet above it. Near the former is the Lake of Gennesareth, 700 feet above the Dead Sea, but also 700 feet below the Mediterranean level. The waters of this lake are generally sweet, cool, and refreshing, though several salt springs enter it at various points. The bed is a lower platform of the Jordan valley.

Lakes are for the most part only moderately deep, but there are important exceptions. They vary in dimensions from the small lakes of Scotland or England to Lake Superior with its area of upwards of 40,000 square miles. Although lakes are generally fresh, some are loaded with saline and other foreign minerals to the extent of nearly one-third of their whole contents. In these cases the prevailing material is not common salt, but chiefly chloride of magnesium. Lakes exist in all countries, and even in most parts of them, so that their number is almost infinite; but the principal examples are generally in groups connected with the great drainage systems of the countries in which they occur. The principal groups of lakes in the various large tracts of land are noticed under the names of the different countries in which they are found.

The origin of lake basins in mountain countries has recently been a subject of discussion among geologists. On the one hand, they have been attributed entirely to the eroding power of water and ice, but chiefly to the latter; and on the other hand, to clefts and fissures produced by mechanical violence during the elevation of the mountain chains.

Lake Iron-ore. A Bog iron-ore, found in the northern parts of Finland and in Sweden, in the neighbourhood of reed-banks and on the slopes of the larger and deeper lakes. [Brown Iron-ore.]

Lallation (Lat. lallare, *to sing lullaby*). The imperfect pronunciation of the letter *r*, which is made to sound like *l*; hence also the term *lambdacismus*.

Lama. Among the Mongols, a title given to priests in general; among the Calmucks, to the higher classes of priests only. The Dalai-Lama (i.e. Great Lama) is honoured by various tribes of Tartaric descent as the representative of divinity, or rather as a real divinity dwelling on the earth. This personage resides at Lassa in Thibet, and pilgrimages are made to his residence by the inhabitants of many distant regions of Tartary. He is now chiefly dependent, in a political sense, on the Chinese empire. When the actual Dalai-Lama dies, his spirit is supposed to seek another body in which to be born again; and the new Dalai-Lama can only be discovered by a certain favoured class among the priests. The worshippers of the Dalai-Lama also pay peculiar reverence to two other subordinate Lamas (Teeshoo and Taranaut Lama). They are distinguished by the title of *Yellow Caps*: the *Red Caps*, another sect in Tartary, are under three other Lamas,

styled the three *Shamonars*. See Huc and Gabet's *Travels in China and Thibet*, an interesting but perhaps not altogether trustworthy work.

Lama, Llama, or **Glama.** The name of a species of the camel tribe peculiar to South America. [AUCHENIA.]

Lamantin. The name given by French naturalists to the manatee or sea-cow. [MANATUS.]

Lambdoidal Suture. The union of the parietal with the occipital bones; shaped in man something like the Greek letter Λ or *lambda*.

Lamella (Lat. dim. of lamina, *a plate of metal*). In Botany, the foliaceous erect scales appended to the corolla of many plants, as in *silene*; also the gills forming the hymenium of an agaric, and the plate or thin part found at the end of many styles.

Lamellibranchiates (Lat. lamella, and branchiæ, *gills*). An order of Acephalous Molluscs, comprehending those which have the gills in the form of large semicircular layers disposed symmetrically, two on each side.

Lamellicorns (Lat. lamella; cornu, *a horn*). The sixth and last section of Pentamerous Coleoptera of the system of Latreille, in which the antennæ are inserted into a deep fossula under the lateral margin of the head. These antennæ are always short, usually consisting of nine or ten joints, and always terminated in a club usually composed of the three last, which are lamellar; sometimes flabelliform, or disposed like the leaves of a book, opening and closing in a similar way; sometimes concentrically contorted and fitting into each other, the first or inferior then being semi-infundibuliform and receiving the others; and sometimes arranged perpendicular to the axis, and forming a sort of comb.

The body is generally ovoid or oval, and thick. The exterior side of the two anterior tibiæ is dentated; and the joints of the tarsi, with the exception of those of some males, are entire, and without brush or pellet beneath.

The anterior extremity of the head most commonly projects, or is dilated in the manner of an epistome. The mentum is usually large, covers the labrum, or is incorporated with it, and bears the palpi. The mandibles of several are membranous, a character observed in no other Coleopterous insects. The males frequently differ from the females, either by prominences on the thorax or head in the form of horns or tubercles, or by the largeness of their mandibles.

This family is very numerous; and is one of the most beautiful of the order for size of body, and the variety of forms exhibited in the head and thorax, and frequently also for the splendour of the metallic colours which ornament the species feeding on living vegetables. The other species, however, feeding on decomposed vegetable matter, are usually of one black or brown hue. Some of the Coprophagi, however, do not yield even in this respect to the former. They are all furnished with wings, and their gait is heavy.

The body of the larva is long, almost semicylindrical, soft, frequently rugose, whitish, and divided into twelve annuli, with six squamous feet: the head is squamous, and armed with stout mandibles. Each side of the body is furnished with nine stigmata or breathing pores. Its posterior extremity is thicker, rounded, and almost always doubled under it; so that the back being arcuated or convex, the animal cannot extend itself in a straight line, crawls badly on a level surface, and falls backwards or on its side every instant.

Some of them require three or four years to become pupæ: they construct in their place of residence an ovoid shell, or one resembling an elongated ball, composed of earth or the remains of substances which they have gnawed, and the particles of which are cemented by a glutinous matter produced from their body. Their aliment consists of the dung of various animals, mould and the roots of vegetables (frequently such as are necessary to man), of which they sometimes destroy immense quantities, to the great loss of the cultivator of the soil.

Lamellirostrals (Lat. lamella, and rostrum, *a beak*). A tribe of swimming birds, the fourth in the system of Cuvier, comprehending those in which the margin of the beak is furnished with numerous lamellæ or dental plates, arranged in a regular series, as in the swan, goose, and duck. The birds comprised in this family pass most of their time in the fresh waters. Some come on shore to graze; others feed on aquatic plants, insects, vermes, or small fish, and reptiles, which their long neck enables them to reach or seize with facility. Some of the species dive in quest of their prey, and can remain a considerable time under water. All the Lamellirosters of Cuvier were comprised in the great genus *Anas* of Linnæus.

Lamia (Lat. and Gr.). An imaginary being, concerning which many superstitious notions were prevalent among the Greeks and Romans; sometimes represented as a species of monstrous animal, sometimes as a spectre or vampire. The Lamiæ of Pliny are animals, with the face and head of a woman and the tail of a serpent, inhabiting the deserts of Africa. According to mythologists, the first Lamia was a daughter of Neptune or Belus, who seizes and devours new-born infants in their cradles. In the story of Machates and Philemon (from which Goethe has borrowed his ballad of the *Bride of Corinth*), a young man is represented as marrying a Lamia, or Empusa, who sucks his blood at night. A similar tale occurs in the *Life of Apollonius of Tyana* by Philostratus. The Christian superstition of incubi, and the Oriental belief in vampires, seem to bear marks of the same origin.

Lamiaceæ. [LABIATÆ.]

Lamidæ. The subdivision or family of *Laminæ*, in which the sides of the thorax are either smooth and rounded, or tuberculate,

rugous, or spiny, but not furnished with movable tubercules or spines.

Laminæ. A tribe of Longicorn beetles, distinguished, according to Latreille, by their vertical head; filiform palpi, whose terminal joint is more or less ovoid and tapers to a point; maxillæ with the outer lobe slightly narrowed at the end; antennæ frequently setaceous and simple; and thorax, exclusive of the lateral spines or tubercules, nearly equal throughout. Some species are apterous, a modification which occurs in no other tribe of Longicorn beetles.

Laminæ Dorsales (Lat. lamina, *a plate of metal*, and dorsum, *the back*). The two parallel ridges which in the embryo of fishes coalesce and form the neural axis and the rudiments of the *chorda dorsalis*, are termed *laminæ dorsales*. The *laminæ ventrales* are downward extensions of the same layer, to include the viscera and the nutrient yolk. These latter, when they coalesce below, form the external (serous or tegumentary) layer of the yolk sac.

Laminaria (Lat. lamina). A genus of olive-spored *Algæ*, the type of the order *Laminariaceæ*. Some of the species are of immense size, such as *L. digitata* and *bulbosa*, which with *L. saccharina* are brought away as hygrometers by the visitors to our sea-coasts. They yield an enormous supply of seaweeds for the preparation of manure or kelp, and delight chiefly in the colder seas of the North.

Laminarites. A term applied by Brongniart to a species of fossil fucus found in the secondary strata of Aix, near La Rochelle.

Lamium (Lat.). A genus of *Labiatæ* of which several species occur wild in this country, and are commonly called Dead Nettles. They are weeds of hedges and cultivated land.

Lammas Day. In the Calendar, August 1. Dr. Johnson supposes this term to be a corruption of *Lattermath*, which signifies a second mowing of grass. Others derive it from a custom which once prevailed in some parts of England, of bringing a lamb alive on this day into the church at *high mass*. Others again derive it from a Saxon term signifying *loaf-mass*, so named as a feast of thanksgiving for the first fruits of the corn.

Lamp (Gr. λαμπάς). The general term for the contrivances used in producing artificial light from the combustion of inflammable liquids. The peculiar applicability of oil to the production of artificial light, which could not fail to be discovered at a very early period, rendered the use of lamps universal among the nations of antiquity. The Egyptians, Hebrews, Greeks, and Romans, vied with each other in the construction of these instruments; and the specimens of some that have been transmitted to our times display much taste and elegance of design. It would seem, however, that they confined themselves to external embellishment: for it is only within the last century that any material improvement was effected in construction.

The most simple lamp consists of a vessel containing oil, and having a depression or spout on one side, holding a wick capable of imbibing the oil by capillary attraction. The oil thus raised through the wick, when ignited, is so heated as to be converted into vapour, which vapour, in a state of combustion, constitutes the flame of the lamp. To render air accessible to every part of the flame so as to insure perfect combustion of the oil, is an essential object in modern lamps; and in this respect the texture, materials, form and dimensions of the wick, are matters of much importance. If the wick be too large, the carbon remains unburnt in the interior of the flame, and produces smoke; and if the wick be too small, the light will be deficient. These inconveniences had been long observed, and many attempts made to remedy them; but it was not till the year 1780, when M. Argand invented the burner which bears his name, that lamps came into general domestic use. The principle on which the superiority of this lamp depends is the admission of air into the centre as well as to the exterior of the flame. This is accomplished by the use of a hollow circular wick, capable of being raised and depressed in the oil-tube, by rackwork, so as nicely to adjust its height to the wants of the flame, while at the same time a copious supply of air is insured by the application of a glass cylinder or chimney, upon the due height and dimensions of which much of the perfection of the lamp depends.

Many modifications of the original Argand lamp have been invented, but the tubular wick and chimney are in almost all cases preserved. The leading improvements in the modern Argands relate principally to the position of the oil chamber, which, instead of being above or on a level with the burner, as in the fountain and sinumbral lamps, are now transposed to the foot or stand of the lamp, from which the wick is duly supplied by the pressure of a spring, which is occasionally wound up. In this way the inconvenience of the shadow of the oil-holder is avoided. By the use of high and comparatively narrow chimneys, the draught of air is so increased as to admit of the smokeless combustion of several vegetable and coarse animal oils. By similar contrivances lamps have been adapted to the combustion of oil of turpentine (camphine), paraffine oils, naphtha, and other analogous hydrocarbons; but the danger arising out of the ready inflammability and volatility of such oils, and their almost invariable tendency to smoke and throw off flocks of carbon, and exhale disagreeable odours, are circumstances which have of late tended to throw them into discredit.

In the chemical laboratory, and in certain artists' workshops, a variety of lamps are resorted to as sources of *heat*: in these, common alcohol, methylated spirit, coal gas, and other fuels, are economically and conveniently consumed. [GAS FITTINGS.]

For simplicity of construction and regularity of action, the *moderator lamp*, invented by M.

Franchol in 1836, is undoubtedly the best. In this lamp the oil, which is contained in a cylindrical vessel usually forming the foot of the lamp, is raised to the apex of the Argand wick by means of a piston acted upon by a spiral steel spring. The flow of oil takes place through a narrow tube, which is more or less choked by a conical wire rising and falling in the tube with the piston itself. When the piston is at the highest point of its range, and when consequently the column of oil to be raised is shortest and the spring exerts its greatest power, the thicker part of this wire produces the maximum obstruction in the tube; but, on the other hand, when the piston is near the bottom of the cylinder and consequently the spring has become relaxed and the column of oil is higher, the thin part of the wire only is engaged in the tube, which consequently offers a smaller resistance to the flow of the oil.

Lamp, Safety. [SAFETY LAMP.]

Lampadephoria (Gr. *a carrying of torches*). A torch race, celebrated several times a year at Athens. The work of training the runners was one of great expense, and was classed among the LITURGIES [which see]. In this race each runner had to carry the torch unextinguished over an appointed extent of ground, and hand it on to another. From this, Lucretius has derived his metaphor for human life:

Et quasi cursores vitaï lampada tradunt.

There are, however, difficulties in explaining the details of this race, which can only be accounted for by supposing that several bands ran at the same time, and that those which carried the torch unextinguished to the end were winners above those in which any one of the runners suffered it to go out. (Smith's *Dictionary of Greek and Roman Antiquities*, s.v.)

Lampadite. A variety of cupreous manganese, found at the mines of Schlackenwald in Bohemia, and named after Lampadius, the Saxon metallurgist.

Lampblack. Finely divided charcoal. It is the soot obtained by the imperfect combustion of resin of turpentine; this is burnt in chambers hung with old sacking, upon which the smoke collects, and is from time to time scraped off. It contains about twenty per cent. of peculiar resinous products, water, and saline matter.

Lampic Acid. A term given by Daniell to the acid produced by the slow combustion of the vapour of alcohol and ether in the lamp without flame: it is acetic acid modified by the presence of a peculiar hydrocarbon.

Lampoon. [SATIRE.]

Lamprey. [PETROMYZON.]

Lampyridæ (Gr. λαμπυρίς, *a glow-worm*). A family of soft-skinned Serricorn beetles, of the tribe LAMPYRINÆ [which see], characterised by antennæ closely approximated at their base; head concealed beneath the thorax, or produced in the form of a snout; eyes of the males large and globular; mouth small. In one division the abdomen of the female is luminous; and the male, which is destined to be attracted by this luminosity, has his head almost entirely occupied by his largely developed eyes, and not produced in the form of a snout. The luminous property of the glow-worm is confined to the two or three terminal segments of the flattened abdomen, which differ in colour from the rest, and are usually yellowish or whitish; this character is peculiar to the true glow-worms, and announces their phosphorescence. The light diffused by the glow-worm is of a lambent, electric, greenish colour: the insect can vary or suspend its luminosity at will. The light-emitting segments preserve their peculiar property for some time after being separated from the rest of the body, and manifest it even in vacuo or when immersed in gases which are not supporters of combustion.

In a second division of *Lampyridæ* the females are not luminous, but are provided with wings; the head is exposed, and is mostly produced in the shape of a snout; the thorax is widened posteriorly, with pointed lateral angles. The elytra, in several, expand posteriorly, where they are sometimes strongly dilated or rounded, especially in the females. To this group belong the genera *Lycus*, *Dictyoptera*, and *Omalisus*.

Lampyrinæ (Gr. λαμπυρίς). A Linnæan genus of Coleopterous insects, which constitutes the type of the present tribe of the soft-skinned or Malacodermous Serricorns in the system of Latreille. This tribe is characterised by the enlarged termination of the palpi, or at least of the maxillary palpi; by their soft, straight, depressed, or but slightly convex body; and by the thorax, sometimes semicircular, at others nearly square or trapezoidal, and projecting over the head which it either wholly or partially covers. The mandibles are usually small, and terminate in a slender, arcuated, very acute point, which is generally entire. The penultimate joint of the tarsi is always bilobate, and the terminal claws have neither dentations nor appendages.

The females of some of the Lampyrine tribe are apterous, or have but very short elytra, and are luminous. All the Lampyrines, when seized, press their feet and antennæ against their body, and remain as motionless as if they were dead. [LAMPYRIDÆ.]

Lanarkite. A carbo-sulphate of lead, found at Leadhills, Lanarkshire.

Lanate (Lat. lanatus, from lana, *wool*). In Botany and Zoology, when a part is covered with fine, very long, flexible, and rather curling hair, like wool.

Lancaster, Chancellor of the Duchy of. The officer before whom, or before whose deputy, the court of the Duchy Chamber of Lancaster is held. This court has special equitable jurisdiction as to lands holden of the duchy. The office has long been a sinecure, and is not uncommonly appropriated to a member of the cabinet.

Lancasterite. A native hydrate of magnesia, from Lancaster county in Pennsylvania.

) (Lat. lancea, Gr. λόγχη). A weapon consisting of a long shaft with a sharp point, much used by the nations of antiquity, and also by the moderns before the invention of gunpowder. The ancient lancea was a general term for missile weapons or javelins: the pilum is termed lancea in Lucan:—

Cujus torta manu commisit lancea bellum.—(lib. vii.)

The Macedonian phalanx and the Roman infantry, as well as the most barbarous nations, all considered the lance as one of the most effective weapons; and even at the present day it is still considered of great value, though it is now borne by cavalry only. Almost all the armies of Europe have now regiments of *lancers*, so called from the lance being the chief offensive weapon with which they are armed. The lances in use among the European cavalry have a shaft of ash or beech wood eight, twelve, or in some cases even sixteen feet long, with a steel point eight or ten inches in length, adorned by a small pennon. [CAVALRY.]

In the middle ages, the terms *man-at-arms* and *lance* were synonymous. To each man-at-arms was allotted a certain number of horses and attendants, such warrior with his followers being then classed as a *lance fournie*. This establishment varied at different periods from three to ten horses. (Hewitt's *Ancient Armour and Weapons in Europe*.)

Lance Corporal. In the Army, the lowest grade of non-commissioned officer. He is distinguished by one chevron on the arm.

Lanceolate (Lat. lanceola, dim. of lancea, *a lance*). In Botany, a term applied to objects which are narrowly elliptical and tapering to each end, as the leaves, the petals, &c.

LANCEOLATE. In Zoology, an animal or a part is so called when it is oblong and gradually tapering towards each extremity.

Lancers. [LANCE; CAVALRY.]

Land (Ger.). In its widest acceptation, this word is used to denote the solid matter of which the globe is composed, in contradistinction to the liquid matter or water; but in its more restricted signification it is confined to *arable ground*. The latter is the legal meaning of the term; and in this sense it is used in all original writs, and in all correct and formal pleadings.

LAND. In Political Economy. The earliest and most important questions which have occupied the attention of economists are those which are connected with the appropriation, the distribution, and the cultivation of the soil. While some kinds of labour are occupied in the developement of useful qualities from raw materials, others with the transfer of commodities from buyers to sellers, and others in promoting and securing the effectiveness of labour itself, that kind of labour which provides first the raw materials of human existence, and next those of comfortable existence, occupies a prominent position for consideration. All those materials of food, of clothing, of shelter, of convenience, are derived from labour exercised on land, either in tilling or mining the soil. Now, as it is clear that the number of persons which can be maintained in any country is primarily to be referred to the rate of agricultural production from the soil, and that, supposing a country imports no food, its population can be no more than the agriculturists in the first place, and the largest number of persons, in the next, who can subsist on whatever remains after the necessities of the agricultural labourer are satisfied, the rate of production from the soil is the gauge of the possible increase of population. And although in a country like this, which has contrived to increase its population largely by the fact that it exchanges a portion of such among its manufactures as it produces beyond its own wants for food from other regions, the existing population is probably much greater than could be maintained from the agricultural produce of the islands, were the whole space as fully utilised as possible; it is still, for obvious reasons, a matter of great importance to decide (as far as may be practicable) the rate of production from land, and the causes, if any, which hinder or prevent a larger increase. So vital was this question to the earlier economists, that the physiocrats of France considered it the first duty of government to develope in every possible way the production of necessaries and utilities from the soil, even if the encouragement given should interfere with or check manufacturing and commercial energies; and so strongly was Adam Smith's mind tinged with the reasonings of his friends Turgot and Du Quesnay, that he endorsed in great measure the opinions which the French economists originated. The view, no doubt, is erroneous; but as the standing point of Adam Smith's enquiry was the proportion subsisting in communities between productive and unproductive consumers, the error was natural, and, on the hypothesis of free exchange, harmless.

In order that agricultural produce should be derived from land at all, *security of tenure* is of fundamental necessity. It is clear that as labour exercised on the cultivation of the soil has a prospective and not an immediate return, the labour will not be exercised at all unless the fruits of labour be secured to the agent by which the labour is set in motion. Hence where there is no government, no order, and no protection to person and property from theft or rapine, agriculture ceases; and where protection is accorded uncertainly or capriciously, there, pari passu, the energies of labour are diminished, and the developement of the art of agriculture is seriously checked. Similarly, where the tenancy of the cultivator is precarious, or the interference of landlords vexatious, or the action of an administration is unfair, it will be found that agriculture languishes, or that out of its many branches of industry those only are prosecuted with energy in which the capitalist or labourer is able to secure to himself the undiminished profit of his activity and intelligence. Thus, for instance, it is quite possible—in conse-

quence of injudicious conditions in a lease, or of absence of security as to the return of capital laid out in improvements, the profit of which cannot be obtained certainly under the terms of a tenancy at will—that the selection of stock may be made with great precision and care, but that the produce of cereals may be far below that which might be obtained by the concession of more liberal terms to the tenant. In short, the very same element of uncertainty which is fatal, when absolute, to agricultural energy altogether, operates in its degree when any risk, due either to unfairness or caprice, is incurred by the tenant. No one who has ever thought or written about agricultural economics has failed to discern that the highest rate of agricultural produce is inconsistent with a precarious tenure, and that it can be secured only by such a lease as guarantees the tenant the full benefit of all the labour and capital which he may find it expedient to introduce upon his holding.

Tenure of Land.—The kind of tenure possessed by the occupier of the soil is of great significance in comparing the actual and possible rate of production. Ownership in fee, that is possession in the fullest sense and with absolute powers of disposition, is plainly the kind of property which will invite the largest amount of capital for the developement of natural resources and for the increase of annual produce. 'The magic of property,' says Arthur Young, 'turns sand into gold;' but precarious possession, or, as he calls it, a nine years' lease, 'will turn a garden to a wilderness.' It is an economical axiom, that unless a man has full power of disposition, with perpetuity of interest in any possession, he will not be very hearty in improving what his feelings tell him is a mere precarious and temporary estate. This, as we know, applies to building houses, to planting and draining, or to otherwise beautifying property. And if a long term of years, far exceeding the possibility of any individual's life, is not a sufficient stimulant for the highest and fullest improvement of the soil, a life estate will be a still weaker inducement for the permanent outlay of capital. And as by far the largest part of the soil of this country is held for life, it is reasonable to conclude that the application of capital to the soil is crippled and hindered, and that if there were a general substitution of estates in fee for estates for life with remainder in fee, the course of agricultural science would be more rapid, and the application of capital more bountiful and continuous; and land being more freely offered for sale, a larger number of persons would devote their accumulations towards its full improvement. Under existing circumstances landlords cannot and tenants dare not improve, the former because the settlement of estates almost invariably involves great indebtedness, and the latter because they have no security that they will not have to pay interest on their own capital.

Division of Land.—In early English economical history, the feudal baron was the ultimate lord over all his tenants, as the king was over all his barons. This lordship, however, was a dormant right, called into activity only by the occurrence of escheat, i.e. by the failure of heirs or the operation of a feudal forfeiture on the part of the tenant. Pending such a contingency, the freeholder was secure in the possession of his estate, and after the statute Quia Emptores (1290) had full power of alienation, and thus the freeholders of the various manors were generally very numerous. They became more numerous and far more powerful during the fifteenth century, having to all appearance thriven on the civil wars; and the English yeomanry were characteristic of this country up to and long after the Restoration. But the invention of strict settlements, and the gradual accumulation of land in few hands, the fruit of the ingenuity of the two conveyancers, Bridgman and Palmer, left no opportunity for the division of land among other than the wealthiest classes of society, when the yeomanry became gradually extinct. Anything more, however, than a bare statement of the process by which the accumulation of real estate has been and is going on, would far exceed the limits of this article. It is sufficient to mention that the greater part of the land of Great Britain is said to be possessed by not more than thirty thousand persons, and that the number is rapidly diminishing. It cannot be doubted that such a state of things is full of economical evils, and perhaps of political danger.

Value of Land.—Land, notwithstanding the expenses attending its conveyance, always represents at present the largest number of years' purchase, or, what is in effect the same thing, the lowest rate of interest. This was not always the case. In the middle ages land was commonly sold at ten years' purchase, and from the time of the Reformation to the beginning of the eighteenth century was seldom worth more than twenty, and commonly only fifteen, years' purchase. Its rise in value is due to many causes. The most obvious is the large increase in rent for the same parcels of land during the last fifty years. It is probable that rents have more than doubled within the present century, and there is reason to believe that the rise in rents is still progressing. Part, therefore, of the increase is due to the prospective advantages of ownership. The scanty amount of land in the market, and the number of persons who, having accumulated wealth, are eager purchasers of land, is another cause for a factitious price. Something, too, must be allowed for the political and social influence which in all countries is appended to the visible possession of the soil, and which in some cases operates so prejudicially to public interests in preventing the distribution of encumbered estates. But it would be a great error to confound, as is constantly done, the low rate of profit obtained from land as an investment, with the rates of profit derived from the abundant application of capital to

land already purchased and cultivated. There are probably few natural objects from which, at the present time, larger actual rates of profit can be derived than from the cultivation of land, provided capital be freely and judiciously employed. The very fact, that the existing and prevalent relations of landlord and tenant are not favourable to the full developement of produce from land, gives a special advantage to the person who unites at once the position of owner, capitalist, and cultivator.

Small and Great Farming.—Much time, probably, has been wasted on the question whether the occupation of small or large farms is economically better and more profitable. The matter must be decided by local or commercial considerations only. In this country, where capital is abundant, where farming is a special business, and where the landlord and tenant are more rigidly distinguished than in any other community, there is and will be a natural tendency to large farming. Such a system has the advantage of requiring a proportionately less amount of dead stock for its operations, and therefore involves a smaller outlay of capital in certain directions. On the other hand, small farming may be in its way of a higher and more careful character, and be less wasteful of the powers contained in the soil. The failure of a particular crop by the large farmer would be set down as a natural contingency; but in the case of a small farmer, an effort might be, and probably would be made, to substitute another crop for the failure, before it is too late to procure one. M. Michelet has dwelt with great distinctness and eloquence on the untiring and devoted energy of the small French farmer. But in countries where capital is scanty, manufactures few and dispersed, and commerce of secondary or little importance, a system of small farming upon permanent holdings becomes an economical necessity. It would be impossible to transfer the English farming system to India, to France, or to Russia; and there can be no doubt that much of the misery and agrarian violence of Ireland is due to the fact, that a land system derived from English legal precedents and legal principles has been forced upon the peasantry, in place of the ancient and more natural tenures to which they were accustomed.

Rate of Production from Land.—Very little information as to the comparative productiveness of the soil in past and present times has hitherto been published, although the enquiry would have been of great historical significance, since it is manifest that the rate of production is the measure of population. From researches which have been carried on for some years past by the writer of this article, it can be proved that the increase in the rate has been far more considerable than would have been imagined, except on an investigation of facts. It is, perhaps, not too much to say that the average produce of grain from well-cultivated land in the United Kingdom falls little short of forty bushels the acre; including, that is to say, wheat, barley, oats, and the leguminous plants. In some parts of England it is, of course, vastly higher. The writer was informed by a friend —the present (1865) president of the British Association—that in one field which was pointed out to him on the eastern side of Suffolk, ninety-six bushels of wheat were in 1864 reaped to the acre; and the same authority further stated, that, conceiving there must be some mistake, he was assured on enquiry that the amount was not exaggerated. Now it is certain, as the writer can testify from the inspection of many thousand farm accounts of the fourteenth century, that the rate at that time was little over twelve bushels an acre, the amount generally reaped on the American corn lands. Then the system of agriculture necessitated fallows, drainage was imperfect, stocks of cattle were small, weak, and slow in coming to maturity, and the mediæval agriculturist was unprovided with artificial grasses, root crops, and artificial manures. The breed of horses was small, ill proportioned, and weak; so that the power used was expensive and inefficient. On the whole, it may be concluded that ten times the amount of produce, at the very least, is procured from areas equal to those devoted to agricultural purposes five hundred years ago; that consequently ten times the number of persons can be maintained on the same surface, and that the rise in rents, probably eighty times over that of the same land, is due to the enormously increased power of production which agricultural science has rendered possible.

Law of Increase from Land.—Mr. Malthus, in the course of his *Inquiry into the Causes of Population*, a work which forms an era in economical science, was led into a hasty generalisation, which he expressed in an awkward metaphor; namely, that population increases in a geometrical, food in an arithmetical ratio, and that in consequence there were certain physical, pathological, and moral checks to population, in the absence of which the increase of mankind would soon outgrow the means of subsistence. When the theory is corrected, the assertion amounts to this: That when the fertile or most fertile lands in any community are exhausted, the necessity for procuring food compels the cultivation of less fertile lands, and that the phenomenon of rent occurs; the amount of rent being an index of the amount of pressure put upon population by the urgency of the demand for food. There is, therefore, this law traceable: That increased quantities of food are produced at a cost increased above the rate at which food was produced before the demand arises, and that every pressure put upon labour for the means of subsistence, and met by a response, implies an equal return at a necessarily increased charge.

This is not the place in which to discuss the theory of rent [Rent]; but it may be stated that a diminution in the cost of production does not necessarily imply a diminution in rent, for as the taker of the soil at rent is

governed by precisely those motives which influence any other person in any other calling, that is to say by the disposition to procure the average rate of profit on capital and wages for labour, any diminution in the cost of production (prices remaining stationary, or low prices in one department of agricultural labour being compensated by higher prices in another) will simply bring into play that competition for the use of land which is followed by a rise in rent. It is, no doubt, a condition that the demand for articles the cost of producing which is diminished, should increase in the ratio of diminution in order that these effects should be produced on rent; but there is no object in demand which, by its limited quantity and by the fulness with which it satisfies, on the condition of labour, so many demands, is so little liable to diminution in value, as a consequence of a diminution of cost in producing supplies, as the use of land.

In fine, while, as a result of extended trade, the risk of scanty supply in the first necessaries of life is remote and problematical, the question whether the supply of some among the first conveniences of life, as for instance meat, is not unduly exalted by an unnaturally deficient rate of production, is one of great and immediate interest; and with it must be taken the further question, how far this deficiency is to be ascribed to the causes indicated in the article, namely the peculiar tenure of land in this country, and the necessary absence of many among the stimulants to increased productiveness.

Land, Distribution of. The land, or solid portion of the earth's surface permanently above the level of the water surface, is distributed with great apparent irregularity, very large portions being collected in one part, and wide tracts of sea separating these from the other parts. Thus, for example, the area of land north of the equator is very much larger than that which is on the south, and that on the eastern side of the Atlantic Ocean is much larger than that on the western side of the same great tract of sea.

The whole surface of land is estimated at fifty-one millions of British statute square miles, more than three-fourths of which lies north of the equator. Of the temperate zones, the land is thirteen times greater in the northern than in the southern hemisphere. Of the whole area occupied by land, only about one twenty-seventh part has water opposed to it in the opposite hemisphere.

A very remarkable excess of water occurs in the hemisphere whose pole is the antipodes of the south-western extremity of England. An observer so placed as to see the whole of that half of the earth of which the south-western extremity of England is the pole, would have almost all the land in view, while the opposite hemisphere would exhibit an almost unbroken water surface. This extreme difference of the two hemispheres is very remarkable.

The most recent estimates of the relative proportion of land and sea are those of Sir John Herschel, who fixes the ratio at seven to eighteen. If the whole surface of the earth be estimated at 100, there are thus 28 parts of land to 72 parts of water.

Of the whole land, estimated at fifty-one millions of square miles, one twenty-fourth part is detached land or islands, and the remainder (Australia being regarded as a continent) is continental.

Land, Form of. There are many important general facts worthy of remark in reference to the form of land. Of these, the pyramidal termination southwards of all the principal land is very remarkable. Africa, Australia, and South America, all exhibit this peculiarity in the southern hemisphere. Hindustan, Arabia, Malacca, in Asia; Italy and Greece, in Europe; and California, in North America; afford similar examples in the northern hemisphere. There are few important exceptions.

The indentations of coast lines are next in order among the phenomena of the form of land. All the eastern coast of the North Atlantic Ocean is deeply indented in detail, while the western coast is little broken. Africa is remarkably free from bays and gulfs, and contrasts singularly with Europe in this as in many other respects. [COASTS.]

The forms of islands are worthy of notice. Those adjoining great continental masses not unfrequently range parallel to the direction of the land. The British Islands, Madagascar, Japan, the islands of the Indian Archipelago, and the Kurile islands are examples. Islands absolutely detached are often in groups of definite form. The islands of the South Pacific, and some of those off Africa in the Atlantic, are instances. [ISLAND.]

The form of land in respect to elevation is another point for consideration. MOUNTAINS, TABLE LANDS, and VALLEYS, all of which are referred to in special articles, exhibit the most marked varieties. [STEPPES; DESERTS; LLANOS.] Very important general principles in Physical Geography are involved in the consideration of these questions.

Land Springs. Land springs are sources of water which only come into action after heavy rains; while constant springs, which derive their supplies from a more distant and deeper source, flow throughout the year. All springs owe their origin to rains. In the case of land springs, the water, when it sinks through the surface, is soon interrupted by a retentive stratum, and forms a spring, which ceases to flow soon after the cause which gave it birth has ceased to operate; but the water which supplies constant springs sinks deeper into the earth, and accumulates in rocky or gravelly strata between impermeable beds; and when these are pierced, the water often rises above the surface. [ARTESIAN WELL.]

Land Steward. A person who has the care of a landed estate, and whose duties vary in different countries according to the mode in which landed property is managed. In [illegible] land, where the landlord very commonly under-

takes to keep the buildings and fences of his tenants in repair, the duties of the land steward are constant and multifarious; while in Scotland, where the buildings and fences are kept in repair by the tenant, the duties of the steward are limited to receiving the rents, and seeing that the covenants of the leases are duly fulfilled. In many parts of the Continent, and particularly in Italy, where the landlord is a partner with his tenant and shares the produce with him, the duties of the land steward, or *fattore*, as he is there called, are much more onerous than in Britain.

Land Tax. In Finance, a deduction, for the purposes of public expenditure, out of the profit derivable from the rent of land, or from its produce. Land taxes almost invariably form a part of the revenues of the king or of the administration in all settled countries. In the great majority of cases, they are of the nature of a tithe; that is, the government takes a variable portion of the produce either in kind or at a valuation of the produce, and sometimes in addition to this form of the tax determines what kind of crop shall be grown either wholly or partly on the land occupied by the cultivator, as in India, where the growth of opium and indigo is enforced by such regulations. However objectionable may be the form or the effect of such taxes, they are, generally speaking, a necessity, there being no means in poor countries by which a revenue can be obtained except by a land tax in the case of the wealthier part of the community, and by a poll tax, and some excise or customs duty on an absolute necessary of life, as salt, which will be borne by the poorer classes. A land tax will be found to exist in every European state, and is a fundamental feature in the Indian revenue system, where it is enforced by a legal maxim, that the absolute and real ownership of the soil is the property of the monarch and, by implication, of his successors, the actual owners being considered as occupiers paying, as the case may be, a fixed or a variable rent. So ancient is this theory of a land tax, that it is found in the Vedas.

For the effects of a land tax, the reader is referred to the article TAXATION; at present it will be necessary only to trace the history of the English land tax. In feudal times, the fiscal necessities of the sovereign were supplied partly from the profits of feudal incidents, as fines, reliefs, and the like; partly from grants in parliament, consisting of contributions from personal property under the name of *tenths, fifteenths*, &c.; partly from escuages, originally compositions for military service on the part of tenants of the crown, and arbitrarily imposed; but made liable to the discretion of parliament by a clause in the great charter, requiring assent to their imposition. These escuages were virtually a very heavy land tax, being (if we can trust the value given to a knight's fee in the time of Edward I., and its identity with the same quantity in the reign of Henry II., rather more than a hundred years before) twenty-five per cent. on the gross rental.

In the reign of James I. an attempt was made to effect a composition between the crown and the military tenants, on the basis of commuting the variable incidents of their tenure into a fee farm rent. The plan failed, not, it appears, because the terms of the composition were unfair, but because a fundamental feature in the scheme was the extension of the same composition to the inferior tenants, whose dues were payable to mesne lords, but whose payments on behalf of the lords should be made *through the crown*. With some reason, perhaps, the mesne lords felt that the security offered for their portion of the feudal incidents was of a somewhat problematical character, and the capricious imposts of military tenure were suffered to continue.

A heavy, but on the whole equitable, land tax took the place of the ancient system during the Protectorate. As at the Restoration the acts of the government immediately preceding the re-establishment of the monarchy were nullified, on the quibble that Cromwell had not been a de facto king, and therefore not within the statute of Henry VII., which gives legal authority to de facto governments, the feudal incidents, not having been technically abolished, were necessarily revived; but being felt to be intolerable, their abolition was determined on in the parliament of Charles II. To save the rights of the crown, and at the same time to give an equitable means of relief to the military tenants, it is clear that a tax or tithe should have been imposed; but the parliament, by a majority of one, and in defiance of the remonstrances of the members from the leading towns, abolished the feudal incidents, and compensated the crown by the grant of the hereditary excise. In other words, the landowners emancipated their estates at the expense of the general community.

At the time of the Revolution, it became necessary to support the new establishment by some general sacrifice. Hence, while additional customs and excises were levied, it was no longer possible that land should escape, and in 1693 (4 Wm. & Mary c. 1) a tax was imposed, for the first time since the Restoration, on land. It must be remembered that it was preceded by the hearth and the poll tax, as well as by a variety of similar imposts. The land tax was originally annual, and was assessed on a voluntary principle. Hence it is said (and it is difficult otherwise to account for the singular inequality of the present assessment), that while the friends of the new establishment rated themselves at the full amount of the tax, the Jacobites, too numerous to be affronted or even compelled to contribute to the real exigencies of the state, assessed their contributions at low and even nominal amounts. Be this as it may, the principle on which the assessment was made remained unaltered; and the rate at which a land tax is paid on the income of real estate, and the net proceeds of

patent offices, is identical with that created at the first imposition of the charge.

The full land tax was four shillings in the pound. It appears that the amount was determined by the legal rate of interest at that time, viz. six per cent. But the tax during the first eighty years of its annual imposition was seldom levied at the full rate, land taxes of one, two, and three shillings being ordinarily imposed in time of peace. At the outbreak, however, of the American war, the tax was finally fixed at four shillings on the old assessment, and made perpetual; and ultimately being reckoned as a permanent government lien upon land, it was made capable of redemption, on the payment of its capitalised value, the proceeds of the redemption being applied to the purchase and extinction of a portion of the national debt. The sums received for redemption of land tax, and applied to these purposes, were 75,477*l.*, 55,457*l.*, 42,953*l.* in the years 1861–2–3 respectively.

As the rent of land increases largely without exertion or risk on the part of its owners, it seems natural that it should contribute largely to the public revenue; the more so, as the growth of population is the true cause of the increase of rent. Hence Mr. Mill has urged, that there could be no possible injustice, in case the present value of the land were permanently secured to the owner, in appropriating for the public service all increase in its value, provided such an increase were derived solely from the demand arising from unimproved sites, or for soils on which no capital is being fixed. It is difficult, nevertheless, to see how, if such a theory were adopted in practice, the stimulus to improvement of the soil would be operative in future.

Land Transport Corps. A corps which at the time of the Crimean war performed the duties now carried on by the Military Train. [MILITARY TRAIN.]

Lands. In a rifled gun, the portions of the bore between the grooves.

Land-locked. A term applied to a harbour or piece of water which is so environed by land on all sides as to exclude the prospect of the sea, unless over some intervening land. If a ship is at anchor in such a place, she is said to ride land-locked, and is therefore considered to be safe from the violence of wind or swell of the sea.

Landamman (Ger. landammann). In Switzerland, the president of the diet of the Helvetic republic. The highest magistrate in ten of the cantons also bears the title of landamman; in the others he is designated by various appellations.

Landau. The name given to a carriage which may be opened and closed at the top; so called from Landau in Germany, where they were originally made.

Landes (Fr.). In France, sterile plains covered with heath or broom are so called (probably from the Teutonic 'land'). They have given their name to a department abounding in them (part of the ancient Guyenne).

Landfall. The first land seen after a voyage is so called. A *good* landfall is when the land is seen as expected.

Landgrave (Ger. landgraf). A title taken by some German counts in the twelfth century, who wished to distinguish themselves from the inferior counts under their jurisdiction; and thus assumed the designation of land-graf, or count of the whole country. This was the origin of the landgraves of Thuringia, of Lower and Higher Alsace, the only three who were princes of the empire.

Landmark. A term denoting, in a general sense, anything by which the boundary of a property is defined. In ancient times the correct division of lands was an object of great importance; and various means were adopted to give distinctness and permanency to boundaries. Stones and hillocks were the most usual landmarks. The importance of this subject, among the Israelites particularly, may be judged of from the denunciation, 'Cursed be he that removeth his neighbour's landmark.'

In Naval language, the term *landmark* is applied to any conspicuous object which serves as a guide in entering a harbour, or avoiding a danger.

Landreeve. A subordinate officer on an extensive estate, who acts as an assistant to the land steward.

Landscape (the termination *scape* in this word answers to the German suffix *schaft*, which is really a participle of the verb schaffen, *to make*). The scenery presented to the eye in the country; as also, in its more common acceptation, a picture representing such scenery. A landscape in the latter sense may, however, become allegorical and historical, in the meaning applied by artists to those terms. The chief study of the landscape painter is the vegetable world, air, water, rocks, and buildings. To these he may impart an ideal beauty, and thus elevate his art above mere topographical painting; a term which may be applied to his work, if he merely copies without refinement what is presented to his eye. A landscape may be equally elaborated in all its parts, with a due observance of aërial perspective, because the eye is not necessarily more fixed in viewing a picture than it is in looking at natural scenery. The parts of a picture are viewed in succession, just as the various parts of a landscape present themselves in nature.

Landscape Gardening. The art of laying out grounds so as to produce the effect of natural landscape. Its principles are the same as those upon which the landscape painter proceeds in composing a picture; and though it is an art of which, like many others, everybody thinks he is a judge, it requires, to be properly practised, powers of a much higher order than fall to the lot of most men. Brown, commonly called Capability Brown, was the first who practised the art in this country so as to render himself worthy of the name of an artist. To lay down the principles of the art would be quite impossible in this article; but this gene-

ral observation contains the sum of them: Let selected and beautiful nature be constantly taken as the model, and success must follow.

Landslip. In Geology, a sliding of the land which occasionally takes place near a cliff or mountain side, owing generally to the removal of some supporting stratum by the action of water eating away and undermining the bed, or by frost expanding and contracting some material through which water passes. The immediate causes of landslips are sometimes natural springs; but more frequently natural cracks formed during unusually dry summers in clay, at the bottom of which is a bed of sand dipping towards and emerging at a hill side. The fall of the Ross-berg in Switzerland, and the slip that took place some years ago at Charmouth, near Lyme Regis in Dorsetshire, are familiar examples.

Landsman. On board Ship, a sailor who has not previously made a seagoing voyage. The expression *ordinary seaman of the second class* is gradually taking the place of *landsman*.

Landwaiter. An officer of the customs, whose duty it is upon landing any merchandise to taste, weigh, measure, or otherwise examine the various articles, &c., and to take an account of the same.

Landwehr (Ger. *land-guard*). The militia of Prussia and Austria are so called. [MILITIA.]

Langite. A sulphate of copper forming a crystalline crust on Killas, from Cornwall, and named by Professor Maskelyne, after Dr. von Lang.

Langrel. A particular kind of shot formed of bolts, nails, and other pieces of iron, tied together, and forming a sort of cylinder which corresponds with the bore of the cannon from which it is discharged. It was used chiefly to destroy the masts and rigging of the enemy's ships. The term is now obsolete.

Language (Fr. langage, from Lat. lingua, *the tongue*). Language may be defined as 'the expression of ideas and their various relations by certain articulate sounds, which are used as the signs of those ideas and relations.'

The only speaking animal is man: and from this fact it would seem to follow that the analysis of language must in the end determine the essential distinction between the mental constitution of man and that of brutes. The progress of physical science is constantly lessening the interval which was supposed to separate the bodily structure of man from that of brute animals; and a fold of the brain seems to be almost the only perceptible distinction between them. If, taking all his powers together, we may speak of man as the strongest or most enduring of all animals, yet in many individual attributes he is far surpassed by many; nor do we gain much by taking our stand on his higher moral or spiritual nature. The arguments which are urged to prove an inherent immortality in the human soul, go far, as Bishop Butler has shown (*Analogy* part i. ch. i. p. 25), to establish the same immortality for brutes. It is also clear that our senses differ in no respect from those of lower animals. With the memory of brutes is combined the power of distinction and comparison; while it is certain that they feel pleasure and pain, and exhibit the signs of love and hatred, shame and pride. They have a strength of will which may be not unfrequently matched with that of the human will; and if they are guided in part by instinct, the same must be said of man during the stage of infancy: but no mere instinct will account for the determination with which the spider proceeds to repair its injured web, or gives up its task when it is seen to be hopeless. It is clear also that brutes can communicate to each other their wants and their designs; and the mere power of imitating articulate sounds is possessed in a high degree by the parrot, mocking-bird, and other animals. But whatever their sensations or ideas may be, it is certain that they are not such as to compel the creature to give utterance to them in articulate speech. This defect or limitation, therefore, seems to mark the real distinction between the very highest brute creatures and man, and to result from the incapability of forming any *general ideas*, or of advancing beyond acts of particular perception. In wood, stone, and iron, men may see the common characteristic of hardness, or that of malleability in gold and iron, or of whiteness in snow and milk. This power of generalisation seems to be wholly wanting in brutes. 'If,' says Locke, 'it may be doubted whether beasts compound and enlarge their ideas that way to any degree, this, I think, I may be positive in, that the power of abstracting is not at all in them, and that the having of general ideas is that which puts a perfect distinction betwixt man and brutes, and is an excellency which the faculties of brutes do by no means attain unto.'

But it is obvious that such a conclusion remains a mere deductive theory, until a complete analysis of language has shown that the elementary predicative roots of human speech are such expressions of general ideas. Hence the desire to obtain an answer to some of the most momentous questions, relating to the past history and the future condition of mankind, renders a classification of existing languages a matter of primary necessity. Before the introduction of Christianity, no attempts at any such classification were ever made. The Greek, regarding all races except the Hellenic as mere barbarians, cared nothing for dialects which he despised as unintelligible jargons; and although he subjected his own language to a minute philosophical analysis, there was nothing in the process to lead him to examine the history of its growth. The work of grammatical analysis was first rendered practically necessary by the extension of Roman dominion. When Latin historians adopted Greek as their literary language, such grammarians as Dionysius the Thracian, carrying out the work already begun by the Alexandrine editors, especially in Homeric literature, soon elaborated that grammatical nomenclature in which European scholars have been

trained from their days to the present. But this technical system had been already carried to far higher perfection at a much earlier time in a land of which Greeks and Romans knew nothing. The Sanscrit grammarians had examined with extreme minuteness the whole field of their own speech, embracing every form of the language, regular and irregular, and supplying rules for the employment of every word; and the resemblance of their terminology to that of the Greeks at least proves resemblance if not identity of structure between the two languages. But beyond this task of mere analysis it was impossible to advance except by a comparison of other languages with that which was under examination; and there is no evidence to show that the Greek discovered any marks of affinity between the inflexions of his own language and that of the Latin; while it is certain that Cæsar did not see in the language of the Gauls whom he conquered, a speech which was radically the same as that of his own soldiers. The narrow exclusiveness of national feeling, which led to this contemptuous neglect, received its first blow by the introduction of Christianity, and those who were imbued with its spirit were not long in learning that all dialects except one or two were no longer to be regarded as barbarous. But unfortunately certain theological prepossessions interposed new barriers in the way of a really scientific investigation of language. It was assumed that because all human speech was originally one, therefore all languages were sprung from Hebrew, and might all be traced back to that source. On this task the labour of ages was expended, yet not altogether wasted. If, by dint of twisting and straining, a few words might be said to resemble words of something like a similar meaning in Hebrew, a vastly larger number obstinately resisted the process; while the observations of missionaries and other persons gradually discovered nearer resemblances between words in European languages and words belonging to dialects far more distant geographically than that of the Hebrews. Thus the Spanish Jesuit Hervas identified the Greek *θεός* with the Sanscrit *deva*, and *εἰμί* with the Sanscrit *ásmi*. But further thought or research showed that no certain bounds could be placed on the importation of words from one language to another; and that, as long as men were busied only in making lists of words simply from their phonetic resemblance, they were drawing up mere barren catalogues of similar sounds. This conviction led Leibniz to maintain that if anything was to be done to good purpose in the classification of languages, it must be by a diligent accumulation of facts, and by a careful arguing from the known to the unknown; and as soon as it was felt that languages must be classified not by similarity of words, but wholly by their grammatical construction, the attainment of a true science of language was insured. The attention of grammarians was thus turned more and more to an examination of inflexional forms, and it was admitted that without a knowledge of their origin and nature we could not be said to have a real knowledge of the languages in which they occur. Thus if the addition of *d* to *love* converts a thing of the present into a thing of the past, if *r* added to *amo* changes an active verb to a passive one, we must know what these letters *d* and *r* really are, before we can claim really to know our own language or the Latin. Hence in each case it became necessary to trace back each given word with its inflexions to the oldest form in which they appear in that language. The present forms of English words vary indefinitely from those of the same language in long past ages: and therefore we have to trace our present terminations and suffixes through every period of our language to Anglo-Saxon; but this very name shows that we cannot stop here; and after comparing that dialect with the Saxon of the Continent, we must compare it with every other Low German dialect, and these with all other German dialects, until we reach the Gothic of Bishop Ulfilas.

But if by so doing we establish the fact of a certain group of languages connected with each other, we have not determined the nature of that connection. Is the Gothic the parent of this whole group, or itself the outgrowth of some earlier stock? Are there other languages besides these belonging to the same branch, or others which with them make up a larger class of languages? and if so, what place does this class occupy in the great field of human speech? The same questions demanded an answer from those who examined what are known as the Romance languages. It was clear that French, Spanish, and Italian were related to each other; but are they sprung from the Latin directly, or through the intermediate Provençal? and again, is Latin really the one source of all, and has the group to which these dialects belong anything to do with the Hellenic dialects on the one side, and the Teutonic, with the German and English, on the other? Such a classification, if possible, would go far towards solving the most important problems connected with human speech; and such a classification became possible when European philologists became acquainted with Sanscrit. This language, which is admitted by all to have been the language of the Brahmans in the time of Alexander the Great, carries us back by the internal evidence of its literature to at least the second millennium before the Christian era. But the mere question of its age is of secondary interest: its real importance lies in the light which it throws on all the European languages except such allophylian languages as the Basque. [Turanian Languages.] The system of Sanscrit grammar was seen to be substantially identical with that of the Greek: the same laws were discerned as regulating the declensions and conjugations of both; their numerals, articles, and pronouns were the same, while many words which were used as prepositions in the Greek were found in the form and with the force of nouns in the Sanscrit. Hence the conclusion was finally established

that the relation of languages was to be measured by the similarity of grammatical forms, and that this resemblance must in its turn be tested by the laws of phonetic change. The relative age of each remained a question wholly of internal evidence, but it was clear that the presence of a single more perfect grammatical form was proof that the language in which it was found could not be the offspring of any other in which the same form existed in a less perfect state. We may take the following paradigm of the auxiliary verb:

	Italian	Wallachian	Spanish	French
I am	sono	sum	soy	suis
Thou art	sei	es	eres	es
He is	e	6	es	est
We are	siamo	suntemu	somos	sommes
Ye are	siete	'su'nteti	sois	êtes
They are	sono	su'nt	son	sont

These, it is clear, are mere variations of one common type; but none of them explain themselves. We cannot understand why *sum* in Wallachian should be *soy* in Spanish, or why *suis* in French should in the second person change into *es*. These forms, then, could not have originated on French, or Italian, or Wallachian soil. But by the aid of Sanscrit we obtain another set of paradigms.

	Sanscrit	Lithuanian	Doric	Latin	Gothic
I am	ásmi	esmi	ἐμμι	sum	im
Thou art	ási	essi	ἐσσὶ	es	is
He is	ásti	esti	ἐστί	est	ist
We (two) are	'svas	esva	. . .	. . .	siju
You (two) are	'sthás	esta	ἐστόν	. . .	sijuts
They (two) are	'stas	(esti)	ἐστόν	. . .	. . .
We are	'smás	esmi	ἐσμές	sumus	sijum
You are	'sthá	este	ἐστέ	estis	siju
They are	santi	(esti)	ἐντί	sunt	sind

This table, it is true, exhibits some older forms, and carries us a stage or two farther back in the history of their developement; but we cannot say that we find in any of them the common and earliest type of them all. That the Sanscrit is not the original, is clear from the fact that the Greek form is in many instances more primitive. The Sanscrit *'smás* has lost the radical vowel which is retained in the Greek ἐσμές; and the same remark applies to the Sanscrit *'sthá* as compared with the Lithuanian *este* and the Latin *estis*. So again the Greek ἐντί, for ἐσεντί, has lost the radical *as* altogether, while the Latin has at least preserved the *s* in *sunt* = *sánti*. A comparison of the two tables still further refutes the theory of Raynouard, that Provençal alone was the daughter of the ancient Latin, and in its turn the only source of French and Italian, Spanish, and Portuguese. The crippled Provençal forms, *sem*, *etz*, *son*, could not possibly have been changed back into the more primitive French forms *sommes*, *êtes*, *sont*. But it remains nevertheless a fact, that the English *am*, the Latin *sum*, the Greek εἰμί, the Lithuanian *esmi*, and the Sanscrit *ásmi*, are all variations of one common type, and that this type was furnished by the language spoken before the separation of the progenitors of the several tribes or races which have spoken these or other cognate dialects down to the present time. And this fact of an affinity which has nothing to do with subsequent intercourse (for the majority of these races have, since they left their common home, been as much separated as if they had been inhabitants of different planets) furnishes also the measure for determining to which language any given word belongs. No facts in philology are better ascertained than these, that the grammatical systems of languages are never exchanged, and that there cannot, therefore, be such a thing as a mixed language. But words may be imported to any extent. The Persian vocabulary is full of Arabic words; the Araucan dictionary has even a larger number of Spanish than of Indian words; yet the inflexional system of these languages is in no way affected by the circumstance. If, then, we find that the Latin vinum represents the Greek *οἶνος*, *wine*, and the Latin ovis the Greek *ὄϊς*, *a sheep*, it may be possible, probable, or certain, that the Latin may have imported the word from the Greek; but a notion of conscious borrowing cannot possibly be applied to the words in the following table:—

	Sanscrit	Greek	Latin	Slavonic	Irish
Father .	pitár	πατήρ	pater	. . .	athair
Mother .	mâtár	μήτηρ	mater	mati	mathair
Brother .	bhrâtar	(φρατήρ)	frater	brat	brathair
Sister . .	svásar	. . . .	soror	sestra	siur
Daughter	duhitar	θυγάτηρ	. . .	dukta	dear

Such comparisons, while they prove the absolute impossibility of borrowing or importation from one dialect into another, throw also a flood of light on the social and moral condition of the several races, and of the common parents from which they sprang. The names for numerals, for domestic and other animals, for articles of clothing, for agricultural and other implements, for houses and other buildings, and for natural phenomena, furnish indisputable evidence of their social condition, both intellectually and morally. But this subject, momentous and interesting as it is, belongs properly to the history of Aryan civilisation, and cannot be further treated here. It is more necessary for our present purpose to remark that a comparison of these inflexional systems shows that the Latin never passed through the Greek; while it becomes, for similar reasons, equally certain that the Romance languages have not sprung from the Latin, but owe their origin to unwritten Italian dialects, sprung from the same stock to which the Latin itself belongs. This conclusion is of the highest importance, as it enables us to rate at their true value the literary dialects of Greece, Rome, and England. Such languages, however graceful or powerful, have passed into an artificial condition of arrested growth, and are really in a state of decay. They have lost the power of regeneration which the vulgar dialects retain; they are exposed not less than the dialects to phonetic corruption, and cannot issue out into new forms by any powers of their own. Into this state of stagnation the Latin dialect was brought when it became a literary language. 'It could not grow,' says Professor Max Müller (*Lectures on Language*, first series, p. 58), 'because it was not allowed to change

or to deviate from its classical correctness. It was haunted by its own ghost. Literary dialects, or what are commonly called classical languages, pay for their temporary greatness by inevitable decay. They are like stagnant lakes by the side of great rivers. They form reservoirs of what was once living and moving speech, but they are no longer carried on by the main current. At times it may seem as if the whole stream of language was absorbing these lakes, and we can hardly trace the small rivulets which run on in the same bed. But if lower down, that is to say later in history, we meet again with a new body of stationary language, forming or formed, we may be sure that its tributaries were those very rivulets which for a time were almost lost out of our sight. . . . As soon as a language loses its unbounded capability of change, its carelessness about what it throws away, and its readiness in always supplying instantaneously the wants of mind and heart, its natural life is changed into a merely artificial existence. It may still live on for a long time, but while it seems to be the leading shoot, it is in reality but a broken and withering branch, slowly falling from the stock from which it sprang. The sources of Italian are not to be found in the classical literature of Rome, but in the popular dialects of Italy. English did not spring from the Anglo-Saxon of Wessex only, but from the dialects spoken in every part of Great Britain, distinguished by local peculiarities, and modified at different times by the influence of Latin, Danish, Norman, French, and other foreign elements.' In the same way, a comparison of the several high and low German dialects shows that there never was one common Teutonic language. The Gothic of Ulfilas has no more claim to the parentage of the other forms, than Sanscrit to that of Greek, or Greek to that of Latin. But all these, together with the Celtic, Scandinavian, Lithuanian, and other dialects, point to the common language of an earlier time, when the ancestors of all these branches of the human family still dwelt in the same home.

To this great tribe of languages, Frederic Schlegel gave the name Indo-European; but this title, as upholding too much that geographical system of classification which had been the fruitful source of so many errors, has been displaced by that of Aryan—a designation adopted by large portions of this family of nations, if not claimed originally by the parent stock itself. The root of this name is found in Gr. ἔρα and ἀροῦν, Lat. *arare*, in the participial forms *erde* and *earth*, and in *earing*, an old English word for harvest; but the distinctive force of the root was lost when, from the sense of ploughing and tilling, it passed into a mere title of honour. Thus in the Vedic literature Arya and Sudra give an exhaustive division of mankind, and the Persian distinction of Iran and An-iran is familiar to all. But the evidence furnished by the language, the discovery of which rendered this classification possible, has produced consequences still more important. It has swept away all those theories which treated language as the result of conscious agreement, and which discerned that agreement in the formal, as distinguished from the radical elements of speech, or, in other words, regarded the inflexional terminations of nouns and verbs as arbitrary additions which originally had no meaning. It has shown that all such terminations existed in earlier forms of language as separate words, while it exhibits the workings of similar combinations in more recent dialects. Thus the paradigm of the substantive verb already given, shows that the word for the first person consists of the radical *as*, denoting breath or life, and the personal pronoun *mi*; and the English *am* is as much made up of these two elements as is the Sanscrit *ásmi* or the Lithuanian *esmi*. The other persons of the several numbers are formed by adding to the root the pronouns expressive of those persons; and this process is seen in all varieties of Aryan dialect, although the substitution of a synthetical for an inflexional structure has to some extent obliterated the earlier forms in many modern languages. This result must, doubtless, be in part attributed to the expression of personal pronouns in such languages; the phrase ἐγὼ εἰμί, or *I am*, is strictly speaking tautological; but the practice is sure in the end to weaken the inflexional structure of a dialect to which it is applied. The closeness of the parallelism in earlier stages of speech is exhibited in the following paradigm:—

	Sanscrit	Greek	Latin
I give . .	dadá-mi	διδω-μι	do
Thou givest	dádà-si	δίδω-ς	da-s
He gives .	dádà-ti	διδω-σι	da-t
We give .	dad-mas	διδο-μεν	da-mus
Ye give . .	dat-tha	διδο-τε	da-tis
They give .	dád-a-ti	διδό-ασι	da-nt

But although in the Latin *do* the reduplication of the root and the pronominal suffix has been as much lost as in the French *aime*, yet when needed phonetically, the suppressed suffixes are always at hand. Thus we have in French il aime, Lat. amat, *he loves*; but if the expression is to be inverted, we have immediately *aime-t-il?* The method of forming the tenses has been illustrated in the articles IMPERFECT TENSE, FUTURE TENSE, &c.; and we need only remark that what holds good of Greek and Latin, holds good also of French and Italian. The French future is formed by adding to the root of the verb the inflexions of the present tense of *avoir*, to have; and if after examining the terminations any doubt remained, it would be removed by a reference to the uncompounded Provençal future, *dir vos ai, dir vos em.* The choice of this verb to express future time was arbitrary; but the choice once made, the old grammatical law at once took effect. This instance, however, may serve to show the infinite variety of forms which the same language may assume. It is obvious that instead of taking the Latin *habeo*, I have, as the base of the tense, dirai = habeo dicere, the present

tense of *vado*, I go, might have been adopted, and with *dirvais* a very different form of inflexion would at once have been the result.

The words already examined show further that our nouns and verbs are made up of two radical components, which cannot be further decomposed, and these are the *roots predicative* and the *roots demonstrative*, the latter being sometimes called *pronominal* or *local*. The method (and there can only be three modes) in which the former are combined with the latter determines the class to which any particular language is to be assigned. In many compound words we have, of course, two, or possibly more predicative roots, but in no case have we any mere arbitrary and unmeaning suffix. Thus the English *landscape*, compared with the German *gesellschaft*, exhibits a suffix which is itself the past participle of verb, and the termination *-τερος* in the Greek comparison of adjectives (e.g. *σοφώτερος*) is no pronominal ending, but the predicative root *tar*, to go beyond, which reappears in the Latin *trans* and the French *très* used as a prefix to mark the superlative degree. The adaptability of these roots to express shades of meaning indefinitely removed from the original idea is indeed wonderful. Thus the root *ar*, to plough, was transferred, as in the Sanscrit *aritram*, an oar, from the ground to the sea, which, in Shakspeare's phrase, 'men ear and wound with keels.' It thence passed to the idea of labour in general, as in the Old Norse *erfidi*, the German *arbeit*, the English *errand*, and finally through the Greek *ἀργός*, *ἐργηστής*, *ἄγριος*, Latin *agrestis*, expressing ideas of swiftness, slowness, brilliancy, rudeness, it came to denote in *ars*, art, the highest conceptions of the painter and the poet.

These roots Bopp divided into two classes, roots ending with a vowel and roots ending with a consonant: by Professor Max Müller they are classified as primitive, secondary, and tertiary, the first being simply a vowel, as *i*, to go, or a vowel and consonant, as *ad* to eat, *da* to [illegible]; the secondary comprising those which have a vowel between two consonants; while those which have two or more consonants coming together fall under the third class. The possible combinations of these letters would give many thousands of such roots; but in fact the number used is very small. Sanscrit grammarians reckoned them at 1,700, and probably not more than one-third of that number are actually needed. The language of the English peasant is said to be carried on with 300 words, and Shakspeare was contented with 15,000; but 50 derivatives out of only 500 predicative roots would give a list of 25,000 words. **The mode in which these roots are used enables us to frame a genealogical classification of languages, as it furnishes evidence that the separation of each from the parent stock did not take place until its grammatical system had been completed.** But as such formations as the French future, and the Latin and Greek imperfect, already noticed, show **the wide choice of means available for the construction of new forms, it is perhaps a matter of wonder that we are able to trace the genealogical connection as minutely as we can.** In the AGGLUTINATE LANGUAGES [which see] this classification fails us; but the distinction of pronominal and predicative roots supplies another which is absolutely exhaustive. They may be so combined (1) as to preserve the distinct existence of both, and so to exclude all phonetic corruption, or (2) so that the predicative root may remain intact, or (3) so that both the roots may be modified by phonetic changes.

The first mode marks the RADICAL stage of language, and is seen only in the Chinese, which is therefore a monosyllabic language, in which every root is a word and has its own proper force.

The second, or TERMINATIONAL Stage, comprises the agglutinative or Turanian dialects.

The third, or the INFLEXIONAL stage, includes the written and literary languages of the Aryan and Semitic families, which are, strictly speaking, the only *families* of speech fully deserving that title, the characteristics of the Semitic dialects being that the component pronominal and predicative elements are more palpable than in the Aryan languages; and also that every root in the former consists of three consonants, whence they have sometimes received the name of tri-literal.

The laws of phonetic change are of primary importance in the science of language. The analysis of language has led to the conclusion that 'sound etymology has nothing to do with sound.' The true conditions which regulate phonetic changes in Aryan languages are in great measure comprised in Grimm's law, which may be stated as follows:—

'Wherever the Hindus and the Greeks pronounce an aspirate, the Goths and Low Germans generally pronounce the corresponding soft check (*g*, *d*, *b*), the Old High Germans the corresponding hard check (*k*, *t*, *p*).'

Thus (1) if for the English *yesterday* we desire the German and Greek equivalents, we must expect words beginning with *g* and *ch*, and accordingly we find *χθές* in the latter, and *gestern* in the former. (2) The Greek *θήρ*, *a beast*, is represented by the Latin *fera*, the German *thier*, English *deer*; and if for the English *dare*, we look for a Greek word beginning with *θ*, we find *θαῤῥεῖν*. (3) The Greek *φηγός* is represented by the Latin *fagus*, the Gothic *bôka*, the English *beech*. (4) The English *queen* or *quean* is the Gothic *qinô*, the Greek *γυνή*, Sanscrit *janî*. (5) The English *two*, German *zwei*, Old High German *zuei*, answers to the Latin and Greek *δύο*. (6) Few really Saxon words begin with *p*, and none in Gothic except foreign words, while in Sanscrit the corresponding *b* is very seldom an initial sound, its place being occupied with the labial spiritus *v*. (7) The Greek *κέρας* is represented in the Latin *cornu*, *cervus*, English *horn* and *hart*. (8) The English *three* answers to the German *drei*, Latin *tres*, Greek

τρεῖς. (9) The English *fare*, *ferry*, answers to the Greek *πόρος*, and the Sanscrit *char*. For a fuller illustration of these formulæ, the reader is referred to Professor Max Müller's *Lectures on Language*, second series, v.

With Grimm's law must be combined four propositions, which may be regarded as constituting 'the Magna Charta of the science.'

(1) The same word takes different forms in different languages, as the Latin *ipse* reappears in the Italian *medesimo*, and the French *même*; but (2) even in the same language. Thus the English has received from the French some words which it already possessed in a Teutonic form, the French *guile* being thus set by the side of the Anglo-Saxon *wile*, and *guise* and *wise*, *engage* and *wed*, alike became English words. (3) Different words take the same form in different languages. Thus in Danish *good* is *God*; but the identity of sound between the two words is merely accidental. 'The two words are distinct, and are kept distinct in every dialect of the Teutonic family. As in English we have *God* and *good*, we have in Anglo-Saxon *God* and *gód*; in Gothic *guth* and *God*; in Old High German *cot* and *cuot*; in Dutch *God* and *goed*. Though it is impossible to give a satisfactory etymology of either *God* or *good*, it is clear that two words, which thus run parallel in all these dialects without ever meeting, cannot be traced back to one central point.' But (4) difference of meaning will show that words of the same form in the same language belong really to different roots. The French pronoun *son* represents the Latin *suum*; the noun so spelt is the Latin *sonum*, sound: *louer*, to praise, is the Latin *laudare*; *louer*, to let, the Latin *locare*. The English *cleave* in the sense of striking is the Anglo-Saxon *clifian*; in the sense of severing, it represents the Anglo-Saxon *clúfan*. But it follows, of course, that words which retain no resemblance to each other may be most closely related. Thus the Sanscrit for *tear* is (d)*asru*, which appears in Greek as *δάκρυ*, *δάκρυμα*, in Latin as *lacryma*, French *larme*; in Gothic as *tagr*, English *tear*: and thus is established the identity of the English *tear* and the French *larme*.

Finally, it must be remembered that, although man is distinguished from the lower animals by the power of framing and giving expression to general ideas, yet his speech could never have become the vehicle for any but the merest sensuous thought, if it had not passed through the crucible of metaphor. Speaking from comparatively scanty evidence, Locke with marvellous sagacity concluded that if we could trace to their sources all words which now bear an abstruse signification, 'we should find in all languages the names which stand for things that fall not under our senses, to have had their first rise from sensible ideas.' This conclusion is now fully established by the evidence of comparative philology. Words which denote the Spirit of God meant originally nothing more than the breath of the sky: words expressing the soul or life of man, once meant only air or wind. The wonderful flexibility of these predicative roots may be seen by examining the changes of meaning undergone, for example, by the root *mar* or *mal*, which origina[lly] expressed simply the idea of crushing or g[rind]ing. With this meaning it appears in the G[reek] *μύλη*, the Latin *mola*, the Irish *meile*, and the English *mill* and *meal*. The transition from pounding to fighting is seen in the Greek *μάρναμαι*—while as expressing the ideas of softening or destruction, the root furnished a name for man as subject to disease and death, the *morbus* and *mors* of the Latins, while the gods were *ἀ-μβρο-τοι*, or *im-mor-tales*. Again, under the form *marj*, or *mraj*, the root gave birth to the Greek *μέλγω*, and the Latin *mulgeo*, *mulceo*, all meaning originally *to stroke*; and the corresponding ideas of softness, sweetness, and decay were expressed in the Greek *βλάξ*, *μαλακός*, *μαλθάσσω*, and the Latin *marcidus* and *mollis*. In the same way the root *jan* passed from its original force of making and producing (as in the Sanscrit *janas*, Gr. *γένος*, *γονεύς*, *γυνή*, English, *kin*, *king*, *queen*, *quean*) to the abstract idea of knowing, as in the Sanscrit *jnâ*, the Greek *γνῶναι*, Latin *gnosco*, English *know*; the close relation of these two ideas being best seen in the Teutonic *kann* (can) and *kenne* (ken). Other and more complete illustrations of the metaphorical processes which, from means so poor and weak, produced the wonderful fabric of philosophic language, will be found in Professor Max Müller's *Lectures on Language*.

The ultimate conclusions to which the science of language may carry us are not on all points definitely ascertained. The original form of those primary roots which we call predicative is yet to be ascertained; and the philologists who advocate the onomatopoetic theory, which traces them to imitations of natural sounds, maintain on this point a sharp controversy with their opponents. (F. W. Farrar, *Chapters on Language*.) If their conclusions (which would not at all weaken the argument from the general ideas expressed in predicative roots) can be established, they would further prove that man was originally mute, while the evidence already at our command shows that he was unable during a long period to express more than the merest bodily sensations. Each stage in the growth of language marks the formation of new wants, new ideas, and new relations. 'It was an event in the history of man,' says Professor Max Müller, 'when the ideas of father, mother, brother, sister, husband, wife, were first conceived and first uttered. It was a new era when the numerals from one to ten had been framed, and when words like law, right, duty, generosity, love, had been added to the dictionary of man. It was a revelation—the greatest of all revelations—when the conception of a Creator, a Ruler, a Father of man, when the name of God was for the first time uttered in this world.' [ROOTS.]

The following genealogical table of the Aryan family of languages may serve to illustrate the remarks made in this article:—

LIVING LANGUAGES	DEAD LANGUAGES	BRANCHES	CLASSES		
Dialects of India	Prakrit and Pali; Sanscrit, Modern and Vedic		Indic	S. div.	Aryan family
the Gipsies			Iranic		
Persia	Parsi, Pehlevi, Zend				
Wales		Cymric	Celtic	Northern division	
Brittany					
——	Cornish				
Scotland		Gadhelic			
Ireland					
Portugal			Italic		
Spain					
France	Langue d'oc, " d'oil — lingua vulgaris — Oscan, Latin, Umbrian				
Italy					
Wallachia			Illyric		
Albania					
Greece	Κοινή — Doric, Æolic, Attic, Ionic		Hellenic		
Lithuania		Lettic	Windic		
Russia		South-East Slavonic			
Poland		West Slavonic			
Germany	Middle High German—Old High German	High German	Teutonic		
——	Gothic	Low German			
England	Anglo Saxon				
Holland	Old Dutch				
Denmark	Old Norse	Scandinavian			
Sweden					
Norway					
Iceland					

A more complete table of the Aryan languages, together with genealogical tables of the Turanian and Semitic families of languages, will be found in Professor Max Müller's *Lectures on Language*, first series.

On the subject generally, see Max Müller, *Lectures on the Science of Language*, first and second series, wherein abundant references will be found to all the important philological works of recent writers. [TEUTONIC.]

Laniaries, Dentes Laniarii (Lat.). The long conical and sharp-pointed teeth which are placed next behind the incisors. They are also called *dentes canini* and *cuspidati*. They never exceed $\frac{1-1}{1-1}$ in number in the Ferine Mammalia.

Lanius (Lat. *a butcher*). A Linnæan genus of Passerine birds, forming the typical family of the Dentirostral division of that order in the system of Cuvier. The birds of the family *Laniadæ*, shrikes, or butcher-birds, are characterised by a strong compressed conical beak, more or less hooked, and emarginate near the point, as in the other Dentirostres. The shrikes live in families, and fly irregularly and precipitately, uttering shrill cries; they build in trees, lay five or six eggs, and take great care of their young. They have the habit of imitating a part of the songs of such birds as live in their vicinity. The larger and stronger birds are predatory, and attack, slay, and devour smaller birds; whence the name *Butcher-bird*.

Lansium. This genus of *Meliaceæ* yields the Lansa, Langsat, or Ayer-Ayer, a yellow fruit about the size of a pigeon's egg, highly esteemed in the East. The species *L. domesticum* is a tree with imparipinnate leaves. Its wood is used by the Malays.

Lansquenets, Lanzknechts (Ger. landknechte, *country men or lads*, or lanzknecht, from the *lance* or pike which they carried). The German infantry first raised by the emperor Maximilian to confront that of the Swiss, towards the end of the fifteenth century. The lansknechts were very irregularly armed, the greater part with pikes, but certain companies in every division had muskets. They were raised by voluntary enlistment, and their leaders passed with little reluctance into the service of any power which was willing to pay them. This infantry played a conspicuous part in the wars of Italy, in the first half of the sixteenth century, after which the name fell into disuse.

Lantern (Lat. lanterna). In Architecture, a drum-shaped erection, either square, circular, elliptical, or polygonal in plan, placed on the top of a dome, or on that of an apartment, to give light. [CUPOLA.]

Lantern, Magic. [MAGIC LANTERN.]

Lantern Wheel. In Mechanics, a kind of pinion having, instead of leaves, cylindrical teeth or bars, known as *trundles*, or spindles, in which the teeth of the main wheels act. The ends of the trundles being fixed in two parallel boards or plates, the lantern wheel has the form of a box, or a lantern, whence the name; it is much used in horology, but is now seldom employed in mechanics, for which purposes toothed wheels have been substituted for it.

Lanthanite. Native carbonate of lanthanum.

Lanthanum (Gr. λανθάνειν, *to escape notice*). A metallic substance discovered by Mosander in *Cerite*; it is associated with, and concealed as it were by, the oxide of cerium. The anhydrous oxide of lanthanum is of a brick-red colour: the hydrated oxide is white, and rapidly absorbs carbonic acid.

Lanyards (perhaps connected with the Fr. lanière, *a thong*). On Shipboard, short ropes used in making fast various articles; but more particularly in stretching, by means of deadeyes or blocks, other ropes, as the shrouds, stays, &c.

Laocoon (Gr.). In Greek Mythology, a son of Antenor and priest of Apollo or Poseidon during the Trojan war. While he was

engaged in sacrificing a bull to Poseidon, two enormous serpents, sent by Athena, in revenge for his having endeavoured to dissuade the Trojans from admitting the famous wooden horse within their walls, issued from the sea; and having fastened on his two sons, whom he vainly endeavoured to save, at last attacked the father himself, and crushed him to death in their complicated folds. (Virgil *Æn.* ii.)

This story has gained celebrity from its forming the subject of one of the most beautiful groups of sculpture in the whole history of ancient art. The composition is pyramidal, and represents Laocoon and his two sons writhing and expiring in the convolutions of the serpents. This famous group of sculpture, which was highly praised by Pliny, was discovered at Rome among the ruins of the palace of Titus, at the beginning of the sixteenth century; and afterwards placed in the Farnese palace, whence it found its way to the Vatican. It was executed by Polydorus, Agesander, and Athenodorus, the three celebrated artists of Rhodes.

Lapageria (after Josephine Lapagerie, the first wife of Napoleon Bonaparte). A beautiful genus of twining undershrubs from Chili, belonging to the *Philesiaceæ*. *L. rosea*, with its great bell-shaped rosy-crimson lily-like flowers, is one of the most gorgeous creepers introduced for the ornamentation of our greenhouses.

Lapilli (Lat. lapillus, *a little stone*). Small volcanic cinders.

Lapis (Lat.). In Roman Antiquity, literally a stone; but the term was used among the Romans to signify a mile, at the end of which lapides or stones were erected with a mark thereon to show the distance from Rome. Hence the phrases *tertius lapis, centesimus lapis*, &c., for 3, 100, &c. miles; and sometimes even the ordinal number was used, with *lapidem* understood, as *ad duodecimum*—twelve miles distant. The Roman practice of indicating the distance of one place from another by the erection of stones has been borrowed by almost all the nations of modern Europe.

Lapis Causticus (Lat.). Caustic potash.

Lapis Divinus (Lat.). A compound of nitre, alum, and verdigris, melted together; camphor is sometimes added, and white vitriol substituted for verdigris. A portion of this fused compound dissolved in water formed a celebrated eye lotion; it was hence also called *Lapis ophthalmicus*.

Lapis Infernalis (Lat.). Fused nitrate of silver; often called *lunar caustic*.

Lapis Lazuli (Lat. lapis, and Arab. azul, *heaven*). A mineral of a blue colour, found in masses or nodules (generally in granite or crystalline limestone) mixed with Felspar and Quartz, and often sprinkled with yellow grains of Iron Pyrites. It is a silicate of soda, lime, and alumina, together with a sulphide (probably of iron and sodium). Frequent use is made of it in mosaic and inlaid work, as well as for making vases and other costly ornaments; and when ground to a fine powder, and carefully washed, so as to remove all foreign matters, it furnishes the valuable pigment known by the name of *Ultramarine*. A nodule of considerable size has been found in the basalt of Titterstone Clee Hill in Shropshire; but Siberia, Persia, China and Bucharia are its chief sources. [LAZULITE.]

Lapis Lydius (Lat.). Lydian stone. A silicious slate, used as a *touchstone* for trying the quality of gold and silver by the colour of the streak.

Lapis Ollaris (Lat.). [POTSTONE.]

Lapis Specularis (Lat. from speculum, *a mirror*). The *Specular Stone* of the ancients generally signifies Mica, but sometimes Selenite or transparent Gypsum.

Lapithæ (Gr. Λαπίθαι). In mythical Geography, a people of Thessaly, chiefly known to us from their fabled contests with the Centaurs. The battle between the Centaurs and the Lapithæ has been described by Hesiod and Ovid with great minuteness.

Laplace's Coefficients and Functions. In the calculus of attractions, certain coefficients and functions which were first investigated in the *Mécanique Céleste*. They have their origin in the following considerations. If

$$u=[(x-x')^2+(y-y')^2+(z-z')^2]^{-\frac{1}{2}}$$

denote the reciprocal of the distance between two points (x, y, z) and (x', y', z'); then the following partial differential equation will be satisfied identically:

$$\frac{d^2u}{dx^2}+\frac{d^2u}{dy^2}+\frac{d^2u}{dz^2}=0.$$

[POTENTIAL.] If polar coordinates be employed, then

$$x=r\sin\theta\cos\phi,\ y=r\sin\theta\sin\phi,\ z=r\cos\theta,$$

and putting for brevity $\cos\theta=\mu$, the last equation becomes

$$r\frac{d^2ru}{dr^2}+\frac{d}{d\mu}\left\{(1-\mu^2)\frac{du}{d\mu}\right\}+\frac{1}{1-\mu^2}\frac{d^2u}{d\phi^2}=0,$$

and u or

$$\left\{r^2+r'^2-2rr'[\mu\mu'+\sqrt{1-\mu^2}\sqrt{1-\mu'^2}\cos(\phi-\phi')]\right\}^{-\frac{1}{2}}$$

may be expanded in a series of the form

$$P_0\frac{1}{r}+P_1\frac{r'}{r^2}+\&c.\ \ldots\ldots\ +P_i\frac{r'^i}{r^{i+1}}+\ \ldots\ldots$$

Each coefficient P_i will be a determinate rational and integral function of μ, $\cos\phi\sqrt{1-\mu^2}$, and $\sin\phi\sqrt{1-\mu^2}$ of the i^{th} dimension in μ, and an exactly similar function of μ', $\cos\phi'\sqrt{1-\mu'^2}$ and $\sin\phi'\sqrt{1-\mu'^2}$, whose greatest numerical value will be unity. These coefficients P_0, $P_1, P_2, \ldots P_i$ are called *Laplace's coefficients* of the orders $0, 1, 2\ \ldots\ i$ respectively. Substituting the series for u in the last differential equation, it is easily seen that P_i satisfies the equation

$$\frac{d}{d\mu}\left\{(1-\mu^2)\frac{dP_i}{d\mu}\right\}$$
$$+\frac{1}{1-\mu^2}\frac{d^2P_i}{d\phi^2}+i(i+1)P_i=0;$$

an equation which has been integrated directly by Hargreave, Donkin, Boole, and others. (*Phil. Trans.* 1841 and 1857; Crelle's *Journal* and *Cambridge and Dublin Math. Jour.*) All functions of μ and ϕ which satisfy the last equation, known as *Laplace's equation*, are termed *Laplace's Functions*. Amongst other useful properties of such functions are the following:

1. Q_i and $R_{i'}$ being two Laplace's functions,

$$\int_0^1\int_0^{2\pi} Q_i\, R_{i'}\, d\mu\, d\phi = 0$$

whenever i and i' are different integers.

2. Any function of μ, $\cos\phi\sqrt{1-\mu^2}$ and $\sin\phi\sqrt{1-\mu^2}$ which does not become infinite between the limits of the above integrals can be expanded in one, and only in one, series of Laplace's functions. If

$$F(\mu,\phi) = F_0 + F_1 + \ldots + F_i \ldots$$

represent this expansion, then

$$F_i = \frac{2i+1}{4\pi}\int_{-1}^1\int_0^{2\pi} F(\mu',\phi')\, P_i\, d\mu'\, d\phi'.$$

The writers on Laplace's functions are very numerous. It will suffice here, however, to mention the two most recent special works on the subject. The one is the *Treatise on Attractions, Laplace's Functions, and the Figure of the Earth*, by Archdeacon Pratt (London 1861); the other the *Handbuch der Kugelfunctionen* by Heine (Berlin 1861).

Laplace's Theorem. [LAGRANGE'S THEOREM.]

Lapping. In Artillery, wearing away by friction a very small portion of the surface of the lands of a rifled gun, in order to ease the passage of the shot.

Lapse (Lat. lapsus, *a slip*). In Ecclesiastical Law, the omission of a patron to present a clergyman to a benefice within six months after its being void; in which case the benefice is said to be void, and the right is lost to the patron. In England the right of presentation then accrues to the bishop, and to the sovereign by the neglect of these; and in Scotland it devolves on the presbytery.

Lapwing. The name of a native species of the genus *Vanellus*, dismembered by Bechstein from the *Tringa* of Linnæus. [VANELLUS and TRINGA.] The lapwing or pee-wit (*Vanellus cristatus*, Bechst.) is an inhabitant of this country, and subsists chiefly on worms and the animalcules of the seashore, which it frequents in great numbers. The female makes a simple nest by scraping together a little dry grass, and deposits thereon four eggs, of a dirty olive colour spotted with black. The young birds are covered with a thick down when hatched, and soon begin to run about: at the approach of danger they squat down, and the parent, by a curious instinct, endeavours to attract the attention of the intruder, and draw him away from the spot, by fluttering about with cries of inquietude, or even running along the ground as if lame. In October the lapwings are fat, and in good condition for the table: their eggs are considered a great delicacy.

Laquear (Lat.). In Architecture. [LACUNAR.]

Lararium (Lat.). In Ancient Architecture, the apartment in which the lares or household gods were deposited; it also frequently contained statues of the proprietor's ancestors.

Larboard (Ital. quello bordo, *that side*, contracted in speaking to 'lo bordo). The former term for the left-hand side of a ship to a person standing on it, whose face is turned towards the head. The other side is called the *starboard*; and as, from the resemblance of sound, larboard and starboard were often confounded, the word was officially abolished a few years ago, and *port* substituted arbitrarily for it. [PORT.]

Larceny (Fr. larcin, from Lat. latrocinium, *theft*). In Law, a species of felony, distinguished formerly into simple and mixed: the latter of which was the taking of goods and chattels from the person, or from the house, if above the value of twelve-pence. But this distinction was abolished in 1828. Larceny is the felonious and fraudulent taking and carrying away of the goods and chattels of another. Thefts of things affixed to the freehold, if forming part of what is termed real property, are not larceny at common law; but many offences of this description have been brought within the character of larceny by enactment. Robbery, breaking into and stealing in a dwelling-house, if in the daytime, piracy, &c., are species of mixed larceny. A receiver of stolen goods is indictable either for a substantive felony, or as accessory to the theft or robbery. The law on the subject of this and cognate offences is now consolidated by 'The Larceny Act 1861.' [LAW, CRIMINAL.] The punishment of simple larceny is three years' penal servitude, or two years' imprisonment.

Larch (Lat. Larix). The Common Larch is *Abies Larix*; the American Larch, *Abies pendula*, the Tamarack of the Canadians. [ABIES.]

Larderellite. A native borate of ammonia found at the lagoons of Tuscany, and named after count de Larderel.

Lardite. A kind of Chinese *Figure-stone* or Agalmatolite, named after M. Lardi.

Lares (Lat.). Domestic deities of the Latins, who were probably regarded as the souls of the deceased ancestors of a family. Their worship, however, was not confined to private houses; as there were lares of the city, the country, roads, &c. [PENATES.]

Large (Ital. largo). In ancient Music, a character representing the greatest measure of musical quantity; one large containing two longs, one long two breves, one breve two semibreves.

LARGE. In Sailing, this term is applied to a wind abaft the beam, but not straight astern. *To sail large* is to sail on a large wind.

Larghetto (Ital. dim. of largo). In Music, a movement a little quicker than *largo*.

Largo (Ital.). In Music, a direction for the time, or rather the style, in which a piece of music is to be performed. It is generally un-

derstood to mean *slow*, but the real meaning is *wide, roomy*; a figurative expression for a broad expressive style [ALLEGRO.]

Laridæ. A family of swimming birds, having the gull (*Larus*) as the type. [LARUS.]

Larix (Lat. *the larch*). The name under which some botanists separate the Larch from other species of *Abies.*

Larixinic Acid. A volatile crystallisable acid, contained in the bark of the larch.

Lark (A.-Sax. laferc; Scotch, lavrock: as hawk from hafoc). The common name of the native species of the genus *Alauda* of Linnæus; of which one, the *Alauda arvensis*, is distinguished as the sky-lark or lavrock; the other, *Alauda campestris*, Linn., is called the field-lark. As the species of the present genus differ from most other insessorial birds in resting habitually and sleeping upon the ground, their feet present a singular but simple modification, which at the same time beautifully adapts them to their office of supporting the superincumbent body on a flat surface: it consists in the extreme elongation in an almost straight line of the claw of the hinder toe, which is, at the same time, proportionally robust: thus the plane of support is extended at the expense of the prehensile faculty, which the habits of the lark render of little or no value to it.

The sky-lark is universally admired for the power and melody of its song, and for the beautiful associations inspired by the circumstances under which its notes are most richly poured forth, viz. while soaring aloft to greet the rising sun. It ascends in the air almost perpendicularly, by successive flights, to an elevation at which its song becomes inaudible: its descent is generally oblique. The female builds her nest on the ground, and lays four or five eggs, which are of a greyish brown colour marked with darker spots: she sits about fifteen days, and usually rears two broods in the year. This prolific species is granivorous, and in the winter large flocks congregate together; they are very fat at this season, and are captured in great numbers for the table. [ALAUDA.]

Larkspur. The common name for the plants referred to the genus *Delphinium.* They belong to the order *Ranunculaceæ*, and are for the most part of ornamental character. [DELPHINIUM.]

Larmier (Fr.). In Architecture. [CORONA.]

Larus (Lat.; Gr. λάρος). A Linnæan genus of aquatic birds belonging to the longipennate division of palmipedes in the system of Cuvier, and now raised to the rank of a family comprising several subgenera. The *Laridæ*, or gulls, are characterised by their compressed elongated pointed bill, of which the superior mandible is curved downwards near the end, and the inferior forms a salient angle beneath. The nostrils, placed near its middle, or a little more forwards, are long, narrow, and form a complete transverse perforation: the tail is ample, and sometimes pointed. (*Lestris.*) The gulls are common and numerous on the sea-coast, and feed on the different animal substances which are left on shore or float down with the ebbing tide. The black-headed gull (*Larus ridibundus*, Linn.) breeds on the marshy edges of rivers or fens; the female makes her nest among the reeds and rushes of heath or dried grass, and lays three or four eggs of an olive-brown colour spotted and streaked with dusky red. When the young are able to accompany the parents, they all resort to the sea-shore. The other species of gulls build for the most part in the sand or the clefts of rocks.

Larva (Lat. *a spectre*). A Metabolian insect in its first stage after exclusion from the egg is so called, because its real form is, as it were, masked: the same term is also applied to those reptiles which undergo a metamorphosis, as the frog, when at a corresponding period of existence. The term *grub* is applied to the larvæ of many insects; while that of *caterpillar* is most frequently reserved for the *Lepidoptera.*

Larvæ. Spectres of the deceased were so termed by the Romans. They were held to be mere empty forms or phantoms, as their name indicates, yet endowed with a sort of existence resembling life, since they were to be propitiated by libation and sacrifice. The larva of Caligula, according to Suetonius, was often seen in his palace after his decease. The larvæ are described by Seneca, and often represented in paintings and on gems under the figure of a skeleton; sometimes under those of old men, with shorn locks and long beards, carrying an owl on their hands.

Larvipara (Lat. larva, and pario, *I bring forth*). Those insects are so called which bring forth larvæ instead of eggs, the latter being hatched in the oviduct.

Laryngitis. Inflammation of the larynx. The symptoms are hoarseness, sense of suffocation, great anxiety and restlessness, and spasmodic difficulty of deglutition. The acute form of the disease sometimes terminates fatally in twenty-four hours. Chronic inflammation of the larynx is not an uncommon complaint, and often a very troublesome one; requiring for its relief strict attention to the general health and the careful use of counter-irritation. The acute form of the disease requires local depletion and general antiphlogistic treatment.

Laryngophony (Gr. λαρυγγόφωνος, *sounding from the throat*). The sound of the voice as heard by applying the stethoscope over the larynx.

Laryngotomy (Gr. λαρυγγοτομία). The operation of making an opening into the larynx. [BRONCHOTOMY.]

Larynx (Gr. λάρυγξ). The upper extremity of the trachea. It is a cartilaginous cavity, the superior opening of which is called the *glottis.* Its various parts, anatomically considered, are extremely complex and intricate, especially in reference to its construction and physiology as the organ of voice.

Lascars. The name popularly given to the native Malayan sailors, many of whom are in the service of our mercantile navy.

Laser (Lat.) or **Cyrenaicum.** *Asa dulcis.* A gum resin which was greatly esteemed by the ancients, and obtained from the north of Africa. It is described by Dioscorides (lib. iii. c. 48); and, under the name of *silphion*, by Theophrastus. Different names were given to different parts of the plant which affords it, the term *laser* being exclusively applied to the inspissated juice. From the representations of the plant upon the coins of Cyrene, it appears to have been one of the *Umbelliferæ*, and according to Lindley (*Flora Medica*, p. 52) was in all probability obtained from *Thapsia Silphion* or *garganica.*

Lasionite. A kind of Wavellite, found in slender silky fibres at the mine of St. Jaques, near Amberg, in Bavaria.

Lasso (Span. from Lat. laxus, *loose*). A rope furnished with a noose at one end. It is much used in Australia and America for catching wild cattle. In the British cavalry, ten men per troop are supplied with the lasso, in order that they may, on emergencies, be available for purposes of draught.

Last. In Commerce, a measure of uncertain quantity, varying in different countries and with respect to different articles. Generally, however, a last is estimated at 4,000lbs. (*Commercial Dictionary.*)

Lastage. Ballast or lading in a ship.

Lastrea (after M. de Lastre, of Chatellerhaut). The modern genus of Ferns of which the Male Fern, *L. Filix-mas*, is the type. It is separated from other Aspidiaceous Ferns by its free veins and kidney-shaped sori, owing to which latter character some botanists prefer to place it in *Nephrodium*, in which, however, in a more limited sense, the veins are united. It is a very extensive genus found in all parts of the world.

Lasurite. Blue carbonate of copper. [CHESSYLITE.]

Latania (Latanier, its Bourbon name). A genus of African Palms, with fan-shaped leaves, and forming trees twenty or thirty feet high. The pulp of the fruit of *L. Commersonii*, though disagreeable in flavour, is eaten by the negroes. This species is a native of the Mascaren Islands, and is often cultivated in our hothouses.

Lateen Sail (Ital. latina, *large* or *broad*). A triangular sail having its upper edge fastened to a long yard much inclined to the horizon. It is used on xebecs and other vessels navigating the Mediterranean.

Latent Heat (Lat. lateo, *I lie hid*). When heat is applied to a solid, the temperature of the latter rises until it begins to melt; but even if the application of heat be continued uninterruptedly, a thermometer placed in contact with the melting solid remains stationary until complete liquefaction has taken place. The same phenomenon is observed when a solid or liquid is converted into vapour by heat. During liquefaction or vaporisation a large amount of heat is absorbed without rendering the body hotter, and hence the heat so disappearing has been termed *latent heat*. In such cases the heat thus said to be rendered latent is consumed either in separating the atoms of the body from each other or in moving them into new positions. It, therefore, no longer exists as *heat*; but when the vapour is condensed or the liquid solidified, the amount of heat which has thus been consumed is re-generated. (*Heat as a Mode of Motion*, by Prof. Tyndall, p. 147.)

Lateral Operation. A Surgical term applied to one of the methods of cutting for the stone.

Lateran. A church at Rome, the Pope's see, and the metropolitan of the whole world, dedicated to St. John Lateran. The name is derived from the Roman family of the Laterani, who possessed a palace on this spot, which was seized by Nero, and became from his time an imperial residence. The Lateran palace was given by Constantine to the popes (Milman's *Hist. of Christianity* ii. 361), who continued to inhabit it until their retirement to Avignon, when it was exchanged for the Vatican. The building was then converted into a church. Eleven councils have been held in the Basilica of this name (hence styled Lateran councils in ecclesiastical history), of which four are considered by Roman Catholics to be general. The last of these (or the twelfth general, according to the same computation) is the most celebrated. It was held in 1215 by Innocent III., and is principally famous as establishing the Roman Catholic doctrine of the Eucharist, using for the first time the term *transubstantiation* for the change of the elements. This council was convoked on the occasion of the heresy of the Albigenses, and its exposition of the Catholic faith is directed principally against them. It established also some canons for the maintenance of discipline among the clergy, and that (omnis utriusque sexus) which enforces confession and communion upon all the faithful at least once a year.

Lateritious (Lat. lateritius, from later, *a brick*). This term is applied to the reddish sediment which is often deposited by the urine.

Latex (Lat.). A coagulable sap which circulates in the vessels of the laticiferous tissue of plants. The term is extended to any kind of viscid fluid conveyed in the laticiferous vessels, whether opaque or not.

Lath (Ger. latte). In Architecture, a thin cleft piece of wood used in slating, tiling, and in plastering. Two sorts of laths, single and double, are known amongst London builders, and both of them are made out of Baltic fir; the former being barely a quarter of an inch in thickness, the latter being three-eighths of an inch; the foreign laths are usually split out of oak, and are made of various thicknesses. Pantile laths are long square pieces of fir or oak, on which the pantiles hang. The term has also lately been applied to the wrought-iron strips that serve to fasten the slates or the sheets of metal on a roof; or to the strips that support the filling-in part of a fireproof floor.

Lath Floated and Set Fair. In Archi-

tecture, two-coated plasterer's work; the first is called *laying*, and is executed without scratching, except with a broom. When used on partitions and walls, this kind of work is generally coloured; when on ceilings, it is white.

Lath Plastered, Set, and Coloured. In Architecture, the same as lath laid, set, and coloured in addition; the same definition may be extended to the work called lath pricked up, floated, and set fair for paper, excepting that it receives an additional coating—the pricking-up coat essential for procuring the even surface that is required for paper.

Lathe. An Anglo-Saxon territorial division, of which the etymology is uncertain. Kent is the only county divided into lathes, each of which contains four or five hundreds. Each was originally under the jurisdiction of a lathe-reeve, subordinate to the sheriff of the county.

LATHE. An engine in which rotary motion is given to the object proposed to be turned, the tool intended to act upon it being held or fixed in any requisite position. It is much used, and is, in the hands of the best makers, a very complicated and ingenious piece of mechanism. The old lathes were worked by the foot; but in modern works, the head-stocks are made so large that it is necessary to put them in motion by a steam engine. A good lathe consists of: 1. the frame; 2. the head-stocks, which bear also the differential pulleys, to allow the velocity of the motion to be changed; 3. the rest for the tools; and 4. the corresponding differential pulleys upon the shaft communicating motion; the foot motion would be comprised under the frame.

Lathræa (Gr. λαθραῖος, *concealed*). A curious genus of *Orobanchaceæ*, called Toothwort. The English name arose from the root, which is parasitic on the roots of trees, and is branched, and clothed with numerous fleshy scales, resembling teeth. On this ground the old herbalists considered it a specific for toothache.

Lathyrus (Gr. λάθυρος, *a vetchling*). A considerable genus of *Leguminosæ*, one of the most familiar of which is *L. odoratus*, the Sweet Pea of the gardens. Several other species are cultivated for ornamental purposes. *L. sativus* is grown in the south of Europe under the name of Gesse, or Jarosse: its seeds are eaten in the same way as the chick pea, but are of a superior quality. The whole plant is sometimes cut for forage. The tuberous roots of *L. tuberosus*, not uncommon in cornfields in various parts of Europe, and lately found in Essex, are eaten, boiled or baked, in countries where they are abundant. *L. Aphaca*, which has leaf-like stipules, but no leaflets, and *L. Nissolia*, which has neither leaflets nor stipules, but flattened grass-like leaf-stalks, are two rare annual native plants.

Latialite (from Latium, the old region of the Latins, in Italy). A synonym for Haüyne.

Laticiferous Vessels. One of the elementary tissues of plants, probably a modification of cellular tissue, and consisting of tubes in which Latex is conveyed.

Laticlave (Lat. latus clavus). The broad stripe which Roman senators and patricians were privileged to wear on their robe.

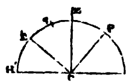
Latin Church. In Ecclesiastical History, a name applied to the church of Rome and the churches in communion with it, as distinguished from the Greek or Eastern or Orthodox communion. As contrasted with the latter, the Latin Church was long distinguished by a less subtle and refined theology, and by greater vigour of action. For a full examination of the characteristics of these two great religious bodies, see Milman, *History of Latin Christianity*, also *Edinburgh Review*, January 1858, p. 64, &c.

Latissimus Dorsi. In Anatomy, a broad muscle of the back which pulls the os humeri downwards and backwards, and assists in its rotatory motion.

Latitude (Lat. latitudo, *breadth*). In Geography, this term signifies the distance of a place from the equator, expressed in degrees of the earth's circumference; or it is the angle which a line perpendicular to the horizon of any place makes with the plane of the earth's equator. In Astronomy, the term *latitude*, as applied to a celestial body, has a different signification, and means the distance of the body, or rather the place of the body, from the ecliptic, or plane of the earth's orbit. The term *declination* is applied to denote the angle corresponding to terrestrial latitude; namely, the distance of a star or planet from the plane of the earth's equator. This double signification of the term is unfortunate, as it tends to create a confusion of ideas; but having been introduced by the early astronomers, and being ingrafted into every existing work on the science, it is now too late to substitute another word in its place.

Latitude and longitude being the coordinates by which the positions of places on the terrestrial surface are defined, their determination forms a most important application of astronomy.

In order to give an idea of the methods of finding the latitude of a place, or of a ship at sea, it is necessary to recall some of the elementary properties of the sphere. Let H H′ be the horizon of a spectator placed at C; C P the direction of the axis of the earth; and C Z the direction of the zenith, or perpendicular to the horizon. Let C E be drawn perpendicular to C P, in the plane determined by the straight lines C P and C Z, or the plane of the meridian; then C E is the intersection of the planes of the equator and meridian; the semi-diameter of the earth being neglected as infinitely small in comparison with the distance of the celestial concave, to which C P, C Z, and C E are supposed to be prolonged. Hence Z is the zenith and P the elevated pole.



Now, by the definition, the angle E C Z is the latitude of C; and it is this angle, therefore,

which is to be determined. The observer always knows his zenith by the direction of the plumb-line; but there is no visible mark in the heavens by which he can at all times determine the place of the equator, or the position of E in the meridian, or even the meridian itself. But the angles E C P and Z C H being each right angles, E C Z is equal to P C H; that is to say, *the latitude of the place is equal to the height of the visible pole.* Now the pole is a fixed point in the heavens, and its position (in the northern hemisphere) is indicated nearly by a star, called the pole star, or *α polaris*, which describes a small circle within 1° 40′ of it. By observing, therefore, the height of the pole star at any place, an approximation to the latitude will be obtained within 1° 40′ of its true value. But this approximation is very far from being sufficient for any useful purpose; it is therefore to be corrected by means of a table called the 'correction for pole star.'

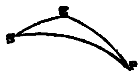
The places of the principal stars being given in the existing catalogues, the observed altitude of any one of them at the time when it passes the meridian will give the latitude of the place. Let S be a star on the meridian, and S P its polar distance in the catalogue, and let its altitude H′ S be observed; then H′ S being known, S Z, the zenith distance, is also known; and S P being also known, we have $SP - SZ = ZP$, the complement of the latitude. In like manner, the latitude may be found by observing the meridional altitude of the sun, or moon, or a planet, the declinations of all these bodies at any time being known. Various methods have been given for determining the latitude by observations of the heavenly bodies; but though all the methods are equally good in theory, they are not all equally practicable, and some of them give results attended with much greater uncertainty than others. The following are those which are chiefly employed.

1. By observing the altitude or (which comes to the same thing) the zenith distance of a star on the meridian. This is the simplest in practice, requiring only a single observation, and no other correction than for refraction. It is accordingly generally employed for common geographical purposes. When the sun or planets are the bodies observed, corrections must also be applied for the semi-diameter of the body and for the parallax. At sea the bodies selected are the sun and moon, the observation of a star or planet being difficult. To know when a heavenly body is on the meridian, it is necessary to have a pretty accurate knowledge of the time; but it may be remarked that near the meridian the altitude varies very slowly, and therefore a small error in respect of the time does not much affect the result.

2. By the altitudes of circumpolar stars (those which never go below the horizon of the place) at their upper and lower transits. If the altitude of a star on the meridian is observed both above and below the pole, the sum of the two altitudes is equal evidently to twice the height of the pole, or twice the latitude. The only correction required is for refraction, which is not the same in the two observations.

3. The latitude may also be found by observing the greatest and least meridian altitudes of the sun in the course of a year. The sum of the altitudes of the sun at the summer and winter solstices is equal to twice the height of the equator, or twice the complement of the latitude; but this method requiring observations to be made at an interval of six months, is seldom employed, excepting in fixed observatories.

4. All the preceding methods suppose the body observed to be on the meridian; but this condition, though it renders some calculation unnecessary, is not indispensable. The latitude may be determined by the observed altitude of a body out of the meridian; and indeed with more certainty, because several observations may be made successively, the mean of which will give a surer result than a single meridional observation. Let P be the pole, S the place of the star or planet, and S Z its observed zenith distance, or the complement of its observed altitude. In the triangle PSZ,



P S, the polar distance of the star, is known; S Z is given by observation; and the hour angle Z P S is given, because the time of the observation is supposed to be known; therefore P Z, the co-latitude, may be found by the solution of a spherical triangle. This method, however, can only be successfully applied by observing near the meridian, unless the exact time of observation is known; and some artifices of analysis are required to adapt the trigonometrical formulæ to calculation.

Another method of finding the latitude is the one called Sumner's method. When one altitude only can be taken, the place of the observer may be assumed to be on a line, which is found as follows. With the estimated latitude of the ship, the altitude, and declination, and by means of the chronometer, showing Greenwich mean time, calculate the longitude. Mark the spot on the chart corresponding to this latitude and longitude. Assume another latitude a few degrees different from the former, and find the longitude as before. Mark the spot on the chart corresponding to this latitude and longitude. Join the two spots thus found, and the place of the ship will be on or very near to the line, or the line produced. If another altitude could be taken an hour or two afterwards, and two spots determined in like manner, the line joining them will intersect the other line on the chart in or near the true place of the ship, and thus the position of the ship will be found very nearly. The estimated latitudes should, if possible, be taken one greater and one less than the true, and within a few degrees of each other; a small diagram or chart bounded by the two parallels of latitude passing through the estimated latitudes may be easily constructed, and the place of the ship indicated thereon by the intersection of the two lines found as above. This method is fully described in Mr. John Riddle's *Navigation.*

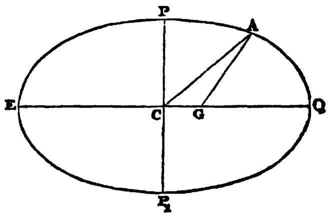
5. The method in most general use for finding the latitude by observations off the meridian is the one known as 'Inman's Double Altitude.' This consists in taking the altitudes of the same heavenly body, or of different heavenly bodies, and noting the interval or elapsed time between the observations: the latitude may then be computed by the application of the common rules of spherical trigonometry.

6. The last method which we shall notice for finding the latitude is one that has been proposed by Bessel, and consists in observing the eastern and western passages of a star through the prime vertical; that is, the vertical plane at right angles to the meridian. When a transit instrument is adjusted to move in this plane, and consequently has its horizontal axis in the direction of the meridian, all the stars which pass the meridian between the zenith and equator will twice enter the field of the telescope. Now let t be the time of the eastern transit, t' the time of the western transit, δ the declination of the star, ϕ the latitude, and P the diurnal arc corresponding to the time $\frac{1}{2}(t-t')$; then the formula by which the latitude is determined is

$$\tan\phi = \frac{\tan\delta}{\cos P}.$$

The advantages of this method are, that the observations may be made with a portable transit instrument, which can easily be oriented by means of the circumpolar stars; a small error in the adjustment will produce no sensible error in the result if the stars observed pass near the zenith; the observations are altogether independent of errors in the division of the instrument; and in determining differences of latitude, errors of declination are also eliminated by observing the same stars at all the stations. It is therefore a very convenient method for use in a trigonometrical survey.

Latitude on the Sphere or **Reduced Latitude.** In consequence of the whirling motion of the earth about its axis, the parts of the equator which have the greatest velocity acquire thereby a greater distance from the centre than the parts near the poles. By actual measurement of a degree of latitude in different parts of the earth, it is found that the equatorial diameter is larger than the polar diameter by about twenty-six miles, the former being about 7,924 miles, the latter about 7,898 miles, and that the form of the earth is that of an *oblate spheroid* resembling the annexed figure, in which PP_1 is the axis, and EQ the equator. It is usual, however, in drawing the figure of the earth, to exaggerate its ellipticity: this is done for the sake of drawing the lines about the figure with greater clearness, for if it were constructed according to its true dimensions the line PP_1 (being only about the $\frac{1}{300}$th part of itself less than EQ) would appear to the eye of the same length as EQ, and we should see that the figure more nearly resembling the earth would be a sphere. The *true* latitude of a point A is the angle formed by AG, a perpendicular drawn to the earth's surface at A with the plane of the equator EQ: thus AGQ is the true latitude of A. The *reduced* or central latitude of A is the angle formed by AC, a line drawn from A to the centre C of the earth with the equator. Thus ACQ is the *reduced* latitude of A, or the latitude considering the earth as a sphere



The difference between the true and reduced latitude is not great; it is, however, of importance in some of the problems in nautical astronomy. The value of this correction for different latitudes has accordingly been calculated, and forms the nautical table called *the correction for the spheroidal figure of the earth.* (For the analytical investigation of this correction, see Jeans' *Navigation.*)

Latitudinarians. In Ecclesiastical History, a class of English divines in the reign of Charles II., who were opposed alike to the high tenets of the ruling party in the church, and to the fanaticism which then distinguished so many of the Dissenters. They were, of course, the objects of much attack; and one of their number, Fowler, bishop of Gloucester, explained their principles in his treatise entitled '*The Principles and Practice of certain modern Divines of the Church of England vulgarly called Latitudinarians, truly represented and defended, by way of Dialogue*, 1670.' Henry Moré and the other Platonising divines of the time were sometimes comprehended under this appellation. The word has been since very generally used to designate those who hold opinions at variance with the more rigid interpretation of Scripture and church traditions, or merely as a term of party vituperation.

Latona. [MINERVA.]

Latria (Gr. λατρεία, *hired service*). In Roman Catholic Theology, this term is applied to the worship of God, the adoration paid to the saints being distinguished by the name *dulia* (Gr. δουλεία, *slavery*), while that which is directed to the Virgin is exclusively known as *hyper-dulia*, or an excess of dulia.

Latrobite. A variety of Anorthite, found, of a pale red colour, in Amitok Island, on the coast of Labrador. It is a hydrated silicate of alumina, peroxide of iron, lime, potash and magnesia. Named after the Rev. C. J. Latrobe, by whom it was first brought to this country.

Latten (Fr. laiton). Brass or bronze. Tinned iron is also sometimes called *latten.*

Latter-day Saints. [MORMONISM.]

Lattice-leaf. (OUVIRANDRA.]

In the Conic Sections, the double of the ordinate at a focus. [CONIC SECTIONS.]

Laudanum (of uncertain derivation). Different preparations of opium have been so termed: the tinctures used formerly to be called *liquid laudanum.*

Laudicœni (Lat.). Among the Romans, persons who (like the modern claqueurs in France, or the puffers in England at auctions) attended the performance of plays and the delivery of orations, in order to raise or to join in the acclamation.

Lauds (Lat. laudes, *praises*). In the Roman Catholic Church, the prayers formerly used at daybreak, between those of *matins* and *prime.* In later times they have become generally confounded with *matins.*

Laughing Gas. [NITROUS OXIDE.]

Laumonite. A variety of zeolite, named after Gillet-Laumont. It crumbles when exposed to air in consequence of loss of water. It is a silicate of alumina and lime with sixteen per cent. of water.

Launch (Fr. lancer, *to hurl out*). The putting of a new vessel into the water. When the vessel is to be launched, a frame called *cradle* is built under her, thus: At about one-third of the extreme half-breadth are laid, on each side of the keel and parallel to it, long pieces of planed timber, forming, as it were, two keels under the principal portion of the vessel. On these are placed vertical timbers meeting the ship's bottom, and maintained from slipping outwards by a strong plank or ribband. This apparatus, which is the cradle, rests on each side upon a platform sloping to the water five-eighths of an inch in one foot; these platforms are called *the ways,* and are planed and greased. The blocks on which the keel was laid being removed with the shores, the vessel rests on the cradle, which is kept from sliding down by a small piece or bar of wood fixed to it lying nearly horizontal, abutting against a place in the ways called the *dog shore,* which being struck downwards falls, and the vessel slides down into the water. When afloat, the cradle, which was only kept together by the ship's weight, breaks up, and the detached pieces are recovered by boats.

LAUNCH. The largest boat carried by a man-of-war, and occasionally provided in very large vessels with guns and a screw engine to enable it to penetrate rivers.

Laura (Gr.). A name applied to the enclosure of a monastery in the Greek or (Orthodox) Eastern Church. The well-known lauras in Palestine, &c. were collections of cells in which hermits lived, in strict seclusion, but without a common monastic rule.

Lauraceæ (Laurus, one of the genera). A natural order of arborescent Exogens of the Daphnal alliance, inhabiting the cooler parts of the tropics and some temperate countries. They are distinguished from all other incomplete apetalous Exogens, excepting *Atherospermaceæ,* by the peculiar dehiscence of the anthers, which open in consequence of the face of the valves rolling back; and from that order by the ovules being pendulous, not erect. The species are generally tonic and stimulant. Cinnamon and Cassia are the produce of some, Camphor of others, and the Common Sweet Bay (*Laurus nobilis*) is a frequent instance of the order in the northern form. A few are so aromatic that their seeds have been used as substitutes for nutmegs.

Laureate (Lat. laureatus). Literally, crowned with laurels. It was from some traditionary belief respecting the coronation of Virgil and Horace with laurel in the Capitol (of which, however, no record is extant) that the dignity of poet laureate was invented in the fourteenth century, and conferred on Petrarch at Rome by the senator or supreme magistrate of the city. It was intended to confer the same honour on Tasso, who, however, died on the night before the proposed celebration. In 1725 and 1776 it was granted to two celebrated improvisatori, the Signor Rufetti and the Signora Morelli, better known by the name of Corilla. [IMPROVISATORI.] In most European countries the sovereign has assumed the privilege of nominating a court poet with verious titles. In France and Spain these have never been termed poets laureate; but the imperial poet, or Poeta Cesareo, in Germany, was invested with the laurel. In England traces of a stipendiary poet royal are found as early as Henry III., and of a poet laureate by that name under Edward IV. Skelton, under Henry VII. and Henry VIII., was created poet laureate by the universities of Oxford and Cambridge, and appears to have held the same dignity at court; but the academical and court honour were distinct until the extinction of the university custom, of which the reign of Henry VIII. exhibits the last instance.

Royal poets laureate are supposed not to have begun to write in English until after the Reformation. The office was made patent by Charles I., and the salary fixed at 100*l.* annually, with a tierce of Spanish Canary wine. Under Queen Anne it was placed in the control of the lord chamberlain. In the reign of George III. the annual tierce of wine was commuted for an increase of salary, and at the close of the same reign the custom of requiring annual odes from the lord chamberlain was discontinued.

Laurel. The common name for *Laurus.* The Cherry Laurel, or Common Laurel of the gardens, is the *Cerasus Laurocerasus.*

Laurencia (after M. de la Laurencie, a French naturalist). A genus of rose-spored *Algæ,* the type of the order *Laurenciaceæ.* It contains some of our commoner seaweeds, as *L. obtusa* and *pinnatifida,* the former of which forms the greater part of what is now sold as Corsican Moss, and the latter is sometimes eaten under the name of Pepper Dulse.

Laurentian Rocks. In Geology, an important group of rocks, deriving its name from the river St. Lawrence, near which they are

developed. These rocks are anterior to those generally recognised as the oldest Silurian and Cambrian strata known in the British Islands. They are, however, believed to be represented by some examples of gneiss and slate in Scotland. Other contemporaneous series will, no doubt, be discovered. Among the Laurentian rocks of Canada very singular indications of the existence of organic bodies have been detected in Serpentine, Epidote, and other magnesian portions of the metamorphosed rock. Of the organic origin of these indications there can be little doubt; but it is not so clear to what group of organisms they may be referred. In appearance they remind the naturalist of the *Rudista*, a group of which, however, very little is really known. They resemble *Foraminifera* in structure, but their size is gigantic. Some naturalists have referred them to the *Spongiadæ*. They have been described by Dr. Carpenter and others under the name *Eozoon canadense*.

Laurin. A fatty matter of an acrid taste, contained in the berries of the common laurel.

Laurostearic Acid. One of the fatty acids of the Bay berry.

Laurus (Lat.). The typical genus of *Lauraceæ*, represented by the Bay or Noble Laurel. The branches of the Bay were used to form the crowns placed on the heads of the heroes of antiquity, and on the statues of the gods. The Bay is in this country an evergreen shrub with aromatic leaves, used on account of their agreeable flavour. Oil of Bay, an external stimulant, is expressed from the fruit.

Lava (from Lat. lavare, as being *washed up*). The molten matter poured out from active volcanoes in a fluid state. Although the word admits of clear definition, the mineral produced is often extremely different in different places. Thus when lava is erupted into the air, the upper part is full of air bubbles, and resembles a coarse ash. It is then called scoriaceous, or simply *scoria*. Not unfrequently similar scoriæ will be found at the bottom of a flood of lava where a thin stream has first come in contact with uneven and damp earth. Below the scoriaceous surface the lava is more compact, and where it has cooled more slowly and under greater pressure, it is found to have assumed a different aspect. The more compact and deeper parts of a lava current are often distinctly porphyritic, while the parts near the surface are sometimes like glass. [OBSIDIAN.]

Lavas differ in composition, but on the whole there is a general similarity in many respects between the lavas of different countries and distant times. The same laws would seem to have always acted in reference to their formation.

Lava poured out under water assumes a different appearance from that which has been erupted in the air. It is more compact, and resembles basalt. [BASALT and VOLCANO.]

Lavandula. A genus of *Labiatæ*, containing two well-known officinal plants, *L. vera*, the common Lavender, and *L. Spica*, which yields oil of Spike; the latter is somewhat the larger of the two. Lavender is an undershrub, with linear grey leaves and close spikes of bluish flowers, from which latter by distillation the essential oil of Lavender is procured. Preparations of Lavender are used both in perfumery and medicine. The oil of Spike, which has a less agreeable perfume, is used by painters on porcelain, and by artists in the preparation of varnishes.

Lavender. [LAVANDULA.]

Lavendulane. An amorphous mineral, of a lavender-blue colour, from Annaberg in Saxony. It is a mixture of arsenates of cobalt, nickel, and copper.

Laver (as it is otherwise called *sea liverwort*, the word looks like a corruption of *liver*). The *Porphyra vulgaris*, esteemed by some as a delicacy. What is called *green laver* is *Ulva latissima*.

Laverna (Lat.). Among the Romans and Latins, Laverna was the patron goddess of thieves. A grove on the Via Salaria at Rome was sacred to her. The origin of the name is doubtful.

Law (Lat. lex). *Law, collective and particular.*—We employ the term *law* to denote a body of rules, or all the rules applicable to a given subject; e. g. the *Roman law*, the *law of nature*. We employ the term *a law* to denote an individual rule.

The idea of law, in its strictest sense, comprehends the notion of two parties; a superior imposing it, and an inferior obeying it.

Laws, improperly or metaphorically so called.—In common language it is usual to apply the word *law* to designate principles or properties which can only be thus named by analogy. Whenever certain causes invariably or generally produce like effects, this consequence of effect upon cause is popularly termed *a law*. Thus we speak of the *law of nature* with reference to inanimate or irrational subjects; of the *law of gravitation*, by which bodies are mutually attracted to each other; of the *laws of motion*, of the *laws* which regulate certain processes in animal and vegetable economy, &c. In this sense, laws have been defined to mean, 'the necessary relations resulting from the nature of things.' The analogy is nobly expounded in a well-known passage of Hooker's *Ecclesiastical Polity*, at the end of the first book.

Law defined.—Law, in its stricter sense, as applied to the voluntary actions of a man, comprises the notion of a command issued by a superior imposing an obligation on a subject.

Laws, Divine and Human.—Laws are divided, according to the superior who imposes them, into divine and human: the law of God, and the law of man.

Law of Nature.—The law of nature, however extensive in its philosophical meaning, is much more confined in that sense in which alone it is within the province of jurisprudence. Regarding it as merely applicable to the relative duties of men in a community, it is sufficient

for practical purposes to observe, with Grotius, that its first principle is the sociability of man; and, consequently, that the conservation of society in its actual state, whether from the motive of mutual distrust, as Hobbes maintained, or from innate benevolence, as his adversaries contended, is the duty which it imposes on everyone.

Let us suppose, therefore, that in a community such as our own there could occur at once a suspension of all civil positive law; and that, at the same time, the sanctions of the divine or unwritten law could be withdrawn. Men would thus be restored to a state of natural liberty. The natural law is that code of duties which would then take the place of all other legislation. Every act tending to injure our neighbour in person and property, every act in any way tending to disturb or impair the frame of society, would then be prohibited by natural law, as it now is prohibited by laws human and divine. Undoubtedly the natural law, in the sense in which it is commonly used, comprehends a far wider range of objects. The duties of personal holiness, the relative duties of the members of a family, the duties of active benevolence; all these are dictated to us by conscience, as much as abstinence from positive injustice. But the province of jurisprudence is too limited to admit of the consideration of these higher parts of morality, and is concerned only with political society.

Law of Nations.—The principle of natural law between individuals in a community would thus be the maintenance of the status quo, or actual condition of things, and the insuring to every one the continuance of all his possessions. This, therefore, is the elementary dogma of that only branch of natural law which can be said to exist as a definite rule of conduct; namely, the law of nations. Nations are in a state of natural liberty with reference to other nations. For, since they have no earthly superior to establish rules for them, the only maxims which govern their intercourse are certain conventional arrangements, the object of which is the maintenance of the existing society and intercourse between the subjects of distinct sovereign states. All the rules of national law have this for their ultimate end. The natural law of men, to use the phrase of Hobbes, teaches the absolute duties subsisting between men and men; the natural law of nations, those subsisting between men in societies: or (in a compendious definition), national law is the law of nature applied to independent states as if they were individuals.

The law of nations, according to the comprehensive arrangement of Mackintosh, comprises 'the principles of national independence, the intercourse of nations in peace, the privileges of ambassadors and inferior ministers, the commerce of private subjects, the grounds of just war, the mutual duties of belligerent and neutral powers, the limits of lawful hostility, the rights of conquest, the faith to be observed in warfare, the force of an armistice, of safe-conducts and of passports, the nature and obligation of alliances, the means of negotiation, the authority and interpretation of treaties of peace.'

But the law of nations, in its practical sense, widely differs from this extensive and philosophical compendium of international duties. Many of the maxims which relate to the subjects here enumerated belong rather to the higher province of morality than to that of jurisprudence. The only punishment of which the sanction can be applied in this species of law is the hostility of other states towards that which violates it. Whoever, therefore, is powerful enough, whether from his own strength or from position and alliances, to defy such punishment, is, in a certain sense, above the law. Hence, although the law of nations, considered as a branch of that of nature, would lay down absolute rules of conduct in the highest as well as the lowest matters of policy within its reach, it may safely be said that the law of nations as a body of recognised right extends only to a portion, and that the least important, of these matters. The only maxims which can be said to subsist as laws are those which are never or rarely violated by European states; because the inconvenience of their general neglect would overbalance the particular inconvenience of adhering to them in a given instance. Thus all will acknowledge that there is a wide difference, in point of preciseness and obligation, between the principles which forbid unjust aggression or severity towards the conquered, and those which prescribe the privileges of ambassadors and the protection of peaceful aliens.

The subjects to which national law is most strictly confined are customary rules respected by the mutual consent of nations, rarely infringed by the voluntary act of a sovereign power, and of which the infringement is considered to require satisfaction and reparation.

It is to be observed, that although several of the maxims of national law (such for example as the sanctity of the persons of ambassadors) are usually held binding in transactions with all nations of the globe, yet the great bulk of its rules are only recognised and observed by the Christian states of Europe and America in their dealings with each other.

National law (from its defective sanction and want of a sovereign legislator as to its details) may, perhaps, be more properly termed the custom than the law of nations.

The reduction of the law of nations to a system was first made by Grotius, in a work which (as Sir J. Mackintosh has well observed), though we now indeed justly deem it imperfect, is among the most complete that the world has yet received, at so early a stage in the progress of any science, from the genius and learning of one man. To him succeeded Puffendorf; who, avoiding the inconvenient and unscientific method of Grotius, has (to use the words of the statesman already quoted), without the genius of his master, and with very inferior learning,

treated the subject with sound sense, with clear method, with extensive and accurate knowledge, and with a copiousness of detail sometimes indeed tedious, but always instructive and satisfactory. In addition to the works of these illustrious authors, the rules of national law are to be found, first, in the treatises of several other authors, who are usually regarded as authorities; of whom Bynkerschoek (*Opera Omnia*, fol. Lug. Bat. 1767; Engl. trans. fol. 1749), Vattell, Wicquefort, Rutherforth (*Institutes* 1779), Von Martens, and others, may be cited: secondly, in the treaties which have been at different times concluded between European states; especially those of Westphalia, 1648; Utrecht, 1713; Aix-la-Chapelle, 1748; Paris, 1763; and Vienna, 1814. A full summary of the bibliography of this subject will be found in the introductory chapter of Mr. Manning's work on the *Law of Nations* (1839). (See also the standard work of Dr. Wheaton *On International Law*, 2 vols. 8vo., and the recent treatises of Sir R. Phillimore and Dr. Twiss.)

The language of conventions and treaties has frequently given occasion to disputes. Subsequently to the revival of letters, and until the peace of Nimeguen (1679), the state language ordinarily used was the Latin; but since that period it has chiefly given way to the French, which is now commonly used between nations employing different languages in their public acts.

Law, Positive or Municipal.—This is the term usually employed to distinguish law, in its ordinary sense (the expression of the will of a supreme power in a state), from all the other species of law (improperly so called) with which we have hitherto been occupied. It is called *positive* law, because established in the form of direct and definite injunctions; *municipal*, from the Latin *municipium*, a town possessed of privileges and local laws.

Positive law is 'a rule of civil conduct prescribed by the supreme power in a state.' Blackstone adds, 'commanding what is right, and prohibiting what is wrong.' But as it is clear that the right commanded and the wrong prohibited acquire the character of right and wrong only from being so commanded and prohibited, the latter half of the definition is evidently comprehended in the first. A regulation or body of regulations, usually adhered to by men in their dealings with each other, but not commanded by the civil power nor enforced by lawful punishment, is properly called a *custom*; but when such regulations, whether set by men to each other on a footing of equality, or by subordinate bodies within the state to individuals, can be enforced by lawful punishment, the sovereign power allowing such punishment, the sovereign power thereby adopts the regulations, and they become laws in the strictest sense of the word.

A law is also defined, 'a command of a political superior obliging the subject to a particular course of conduct.' This definition comprehends most of the civil institutions with which jurisprudence is concerned; but it appears to exclude some which are nevertheless within the province of that science. For example—

1. Many laws are enacted to explain former laws, and also to repeal former laws. Neither of these can be said, in strictness, to answer the definition of law which describes it as a command, unless we consider them as re-enacting former commands. 2. The Roman jurists applied the term 'laws of imperfect obligation' to certain enactments of their law prescribing particular conduct, but without any penalty being expressed in the event of their violation. These were not commands, not being enforced, and could not be said to oblige the subject, who was at liberty to escape the obligation. Our laws recognise no such rules as these. If a statute enjoins or prohibits an action without adding any express penalty, the courts of justice *presume* that a violation of the statute is punishable. Law, as the subject matter of jurisprudence, is that which obliges the subject to a particular *course* of conduct by *general* rules of action. This excludes—

1. Laws made to permit or restrain the acts of specified individuals. Such were called by the Romans *privilegia*, or under the emperor's private rescripts; in our law, *private acts of parliament*. The sovereign body in the state, having the power to repeal and modify its own enactments, can by an expression of its will exempt particular persons from its own injunctions, or can impose new duties on particular persons. Such decrees have all the force of law; but they do not form a part of the general law of the country.

2 Laws made to suit a particular emergency, occasional or particular commands, which are distinguished from general laws by their *shorter duration*. To exemplify this difference, it has been said that should a sovereign command all his subjects to wear black as their ordinary dress, such a command would be a law; but should he order a general mourning for a stated time, such an order would not have sufficient permanence to entitle it to that appellation.

Every command given by a political superior is a law in point of force; but it is necessary to establish some distinction between occasional and general commands, as otherwise every direction of a public officer, every incidental command of a military superior, must be considered as a law. An act to suspend the collection of a duty for a given time, an order in council to admit bonded goods, or to issue any temporary regulations respecting trade and commerce, royal proclamations · all these are familiar instances of the species of occasional or particular commands.

Municipal law is commonly divided into two branches; that which concerns the public duties of individuals with reference to the state, and that which concerns the private relations of individuals towards each other. The division between these branches is not in all systems the same. Under the old Germanic institutions,

for example, most crimes were considered as civil injuries only.

Laws, strictly so called and forming the body of public right in each separate state, are to be found either in codes sanctioned by the authority of the state; or in decrees issued and made public by such authority; or, finally, in certain unwritten customs, to which that authority, by sanctioning them, has given the force of law.

The code of law, under all Mohammedan governments, is to be found wholly or in part in the Koran, which to Mohammedans bears the character both of revealed and civil law. Those of the Hindus and many other nations are likewise considered by them to possess the authority of a religious sanction.

In Western Europe the laws in force in most of its countries, although modified and republished by their several legislatures, are in great measure founded on what is termed the Roman law. This body of law is principally declared in the *Pandects, Code*, and *Institutes* of the emperor Justinian; but these contain only a digest of a small portion of the laws which prevailed in the ancient Roman empire.

The Roman Law.—'Inasmuch,' to use the words of our own learned judge Lord Holt, 'as the laws of all nations are doubtless raised out of the civil law, as all governments are sprung from the ruins of the Roman empire, it must be owned that the principles of our law are borrowed from the civil law, therefore grounded upon the same reason in many things.'—The manner in which the Roman law has been introduced into the jurisprudence of modern Europe may be said to have been twofold: first, through the prevalence of Roman usages, derived from the times of the empire, among the population of various countries, especially that part of it which was collected in towns; secondly, through the efforts of the ecclesiastics, who learnt the civil law from the *Codex* of Theodosius, and from the works of Justinian, and introduced it, as far as their authority extended, into such branches of justice as they were permitted to administer, and especially into their canon law, which the various princes of Europe permitted to be binding, to a different extent in different countries, upon their lay as well as clerical subjects. Thus the Roman law is in one sense the oldest and fundamental part of public right in many countries: in another sense it is a comparatively recent importation, altering the character of their respective legislations. The Roman law comprises what are termed the INSTITUTES, PANDECTS, CODE, and NOVELLÆ [see these terms]. These have been collected and published together, under the title of *Corpus Juris Civilis*; the best editions being those of Amsterdam (8vo. 1664) for the text, and of Gothofred (fol. Paris 1628) for the text and notes. The most elaborate modern work on the history of the Roman law is that of Savigny.

It would be impossible, within our limits, to give the reader any useful bibliographical notice on a subject which in foreign countries has necessarily received such abundant attention and illustration; and English treatise writers on the civil law are few, and of no great value, that law having only existed among ourselves, as we have seen, in certain limited departments.

Civil Law in England.—In England, while in the way of ancient custom there are fewer vestiges of the civil law than in any other of the provinces of ancient Rome, yet in the way of ecclesiastical jurisdiction it has been wider spread and continued longer in force then almost anywhere else.

Although Britain was a highly civilised province possessing 140 cities and towns in the time of the Romans, yet the numbers and violence of her invaders, especially the Saxons and the Danes, appear to have extinguished almost every relic of her provincial customs and jurisprudence It is chiefly, therefore, to the clergy that we are to look for the prevalence of the civil law in England, and it has been introduced by them in several ways.

1. At the Norman invasion a considerable accession to the numbers and influence of the spiritual body in England took place. A century afterwards the discovery of the *Pandects* rendered the study of jurisprudence familiar chiefly among that body, which monopolised most of the learning and intelligence of the age. The clergy introduced it into England; and, as the rude and simple justice of the Saxons was inadequate to meet the wants of the people, most of the early lawyers, who were themselves chiefly ecclesiastics, sought in the pages of their favourite works for principles to supply the defects as they arose. Hence in the works of Bracton, Britton, and Fleta (written expressly on the common law of England, that is the customary law of the Saxons modified by extensive introduction of Norman usages), we find constant reference not only in spirit but in words to the civil law. The time during which the study of the latter was most in vogue among English lawyers appears to have been between the reigns of Stephen and Edward III. During the greater part of that period a constant struggle was carried on between the ecclesiastical lawyers (supported in many cases by the crown) and the popular party in favour of the old customary right, which was defended by the temporal nobility. The final victory of the common law, and its establishment as the rule of the land, except in particular cases, may be dated from the reign of Edward I.

2. The jurisdiction of the lord chancellor of England is a subject considered elsewhere. [CHANCELLOR.] It is sufficient here to remark, that as most of the chancellors under the Plantagenet kings were ecclesiastics, and as the matters intrusted to their decision were those to which the rules of the common law did not apply, they generally searched for precedents in that of Rome; which has hence been largely imported into one great branch of modern English law, namely, *Equity*.

3. In some particular matters the rules of the civil law have always been allowed by custom to prevail in England. Of these, cognisance was taken by the courts of honour and chivalry, now fallen into disuse; by the High Court of Admiralty [ADMIRALTY]; and by the courts of the two universities of Oxford and Cambridge.

4. The chief influence of the civil law in England has been through the canon law, which was founded upon it.

Law, Canon.—The rules which were framed by the Christian church for its own spiritual polity may be supposed to have had their origin in the very earliest periods of Christianity itself; but all the authority and force which they possessed could arise only from the mutual consent of the faithful to be bound by them, until the establishment of Christianity as a state religion entirely altered the character of its spiritual constitution. The temporal jurisdiction which was then conceded to the bishops, together with the legal force given by several emperors, and by Justinian in particular, to the canons of councils, gradually called into existence a new and independent body of legislation.

When the Western Empire had been overthrown, the authority of the popes, as temporal governors, was by degrees confirmed in the city of Rome and the adjacent country. At the same time the power of the ecclesiastical body was increased and extended in other countries; and the reverence attached to their authority gave to the spiritual censures with which they visited particular offences a greater force than to the sanctions of the national law. Thus, besides matters of church government, which were at first the particular subject of the pontifical law, it comprehended within its purview numerous and important branches of the civil law of persons and property.

About the year 1150, the various edicts then in force of the several popes, together with the canons of councils, and the authoritative declarations of fathers and doctors of the church, were collected together by the monk Gratian, and reduced into a volume called the *Decretum*, and considered as the earliest authority in canon law.

In the next century, Pope Gregory IX. published five books of DECRETALS [which see], collected from the Decretal Epistles of the Popes, to which Boniface VIII. added a sixth book, about the end of the same century. To these were added, at subsequent periods, the Clementine Constitutions, a seventh Book of Decretals, and a Book of Institutes. The whole of these authorities were collated and published by Gregory XIII. in 1580, under the title of *Corpus Juris Canonici.*

In matters of evidence, and as far as practicable in the forms of proceeding, the compilers of the canon law founded their system upon that of Rome, with which they were best acquainted. In all such matters of civil jurisdiction as their legislation embraced, they likewise assumed it as the basis of their structure. By the practice of all ecclesiastical courts the civil law is allowed to come in aid of and to supply the canon law, in all such cases as are there omitted. The subjects of the canon law were: 1. The hierarchy and government of the church; 2. All things relating to pious uses; 3. The wills of defuncts, the guardianship of orphans, and matters of marriage and divorce. But it was by no means permanently received, in most European countries, to its full extent. Its jurisdiction only subsisted by the toleration of princes; and therefore varied as the superstition or piety of these sovereigns, or their jealousy of ecclesiastical usurpation, alternately predominated. But, upon the whole, its authority became so deeply rooted, that even in countries which have in later times rejected the authority of the pope, its rules are still referred to, not merely in matters relating to church benefices, but also in some cases of purely civil jurisdiction.

Nevertheless, although in early times its authority was asserted by the popes on the ground of their temporal superiority over all earthly sovereigns, its force in every country must now be said to depend upon the will of the state, which gives the force of law to its provisions.

It is supposed that the decrees and canons of the church of Rome were adopted in this country so early as A.D. 605, shortly after the introduction of Christianity among the Saxons; but they were not fully recognised by the state until after the Norman conquest. From that period the power of the bishops made rapid strides, insomuch that they succeeded in retaining many branches of jurisdiction of which in other countries the temporal power had deprived them. In addition to the general canon law, we have in England a particular provincial law—the *constitutions* of the papal legates and councils of this country in 1237 and 1269; and a further body of constitutions, framed in provincial synods under the authority of successive archbishops of Canterbury, from Stephen Langton in 1222 to Archbishop Chichele in 1414, and adopted subsequently by the province of York. These constitutions have been illustrated by the commentaries of distinguished ecclesiastics, and principally those of Lyndwood, who flourished in the reigns of Henry V. and Henry VI. The canons of the Protestant church passed in the convocation of A.D. 1603, although ratified by King James I. for himself and his successors, yet do not (as Lord Mansfield finally decided) bind the laity, except so far as they declare the older provisions of the law. The most standard work on English Ecclesiastical Law is Gibson's *Codex Juris Anglicani.* The best guides for the student are the compilations of Dr. Burn and Sir R. Phillimore.

Law of England, Common Law.—This expression is used in two different senses, according to the subject under consideration. We speak of the common law in contradistinction

to the civil law, or to equity; meaning a certain portion of our laws relating to a definite subject matter, and administered in courts following particular rules of evidence and modes of procedure. We also, by the common law, sometimes mean the unwritten or ancient customary law; in this sense it is opposed to the statute law, which is of positive enactment.

The constitution and laws of our Anglo-Saxon ancestors have been the subject of innumerable theories and contradictory systems, since the ingenuity of modern times has been applied to their investigation; but all the efforts of the learned have gone no further than to establish the existence of a few principles and customs common, for the most part, to the Germanic tribes in general.

Edward the Confessor reduced the customs of the country into something resembling a system of law; and although his enactments are lost, it is to his reign that we must look for the most authentic form of Anglo-Saxon polity. The king was guided and controlled in his deliberations by the witan, or chief men, assembled in the gemote, or meeting; but their relative power and that of the sovereign varied according to the strength or weakness of the latter. Justice was administered in the county courts, where the *good men* or landowners assembled, and the bishop and sheriff presided. Questions of property were decided by ordeal, or by a tribunal of sworn witnesses. In criminal as well as in civil cases the defendant sometimes freed himself by the oath of compurgators, or wager of law, as it was called when adopted by the Normans. The inhabitants of every district were mutual guarantees, by the custom of frankpledge, which was founded on two principles: the one, the liability of the lord or superior for the appearance of his vassals; the other, the collective responsibility of the tything, or hundred, for all its individual members: which was not prevalent in all England, and entirely unknown in the northern shires.

By the Norman conquest and the division of the better portion of England between Norman proprietors holding in chief of the crown, the feudal system of law, as regarded land and its incidents, was early introduced into the country. Other portions of Norman jurisprudence were imported at a later period, through the medium of the king's courts; which, being at first confined in jurisdiction to the domains of the crown, gradually supplanted the old Saxon courts, although these long continued to be governed by their national law.

The three great institutions in which English law differs from that of other countries—the parliament; the system of tenures and their incidents, on which the law of real property is founded; and the trial by jury—may perhaps be said to have been founded on Norman jurisprudence, but to have become prevalent through their analogy to Anglo-Saxon institutions. [PARLIAMENT.]

The first consequence of the invasion of the Normans was, that different modes of trial were prevalent, according to the nation to which the contending parties belonged. Compurgation or 'wager of law' was the common mode of decision between Englishmen. In criminal cases, it was usually by the oath of eleven compurgators chosen out of an array of fourteen. In civil suits, the amount of the compurgation required seems to have been regulated by the value of the property claimed. To this peculiarly English mode of trial was added the *wager of battle*, which is first named in the laws of the Conqueror, but which either French or English and French might use. *Inquest of witnesses* was a Norman mode of trial in civil cases, by which witnesses were summoned from the neighbourhood in which the quarrel arose to declare on their oath the truth concerning the matter in question. Finally, the ancient proof of *ordeal* subsisted in criminal cases.

This diversity in the modes of trial was accompanied by a diversity of judicature. The ancient county courts received one blow by the withdrawal of the bishops, who ceased to preside in them, being chiefly foreigners, and who gradually established a separate jurisdiction of their own. A still more important wound, in its consequences, was inflicted by the increasing power and influence of the king's courts (at first only confined to causes arising within the royal demesne), in which the Norman law and modes of procedure were adopted, and in which the machine of our own common law was gradually elaborated by judicial ingenuity during successive centuries.

Henry II. is commonly regarded as the founder of the common law. His principal contribution towards it consisted in his ordinance of the grand assize; justices in eyre, or circuit justices of the king's courts, being appointed to try causes by inquest of twenty-four witnesses, at the option of the tenant or demandant, if either party preferred to purchase this mode of trial instead of the ordinary trial by battle. Shortly after his reign the Fourth Council of Lateran, by abolishing the ordeal (A. D. 1215), gave a new impulse to the developement of the jury system. Criminal cases were now tried by a jury of witnesses de vicineto; and the process by which these witnesses, both in civil and criminal cases, became converted into sworn judges of the fact, has never been distinctly traced; but the intermediate steps had certainly all been passed before the reign of Edward III., possibly before the death of the first monarch of that name.

If Henry II. was the founder, Edward I. may almost be regarded as the completer of the common law. From his time to the present no change has taken place in its general principles: all that subsequent reforms have effected has been to accommodate those principles to altered circumstances. And long may the spirit of these institutions remain unchanged amidst the march of improvement; holding together, as they now do, the mightiest commercial community of the globe, with no less beneficial authority than they exercised six hundred years

ago over the barons, peasants, and burghers of a small feudal [illegible] hy!

The system of real property may be said to have been fixed by the statute Quia Emptores, 18 Edw. I. Before that time we may consider the lands of England as having been subject, in general, to the unrestricted feudal law. All land was held, mediately or immediately, of the king. The two classes of free proprietors were those who held by the military service (of Norman introduction), and those who held by the old English custom, their property in their lands being retained by them, subject only to acknowledgement or fealty to the sovereign—a less honourable, but probably a less burdensome tenure. But either of these tenants might, in his turn, create fresh tenants under him, yielding the same homage to him which he yielded to the sovereign. Below these, the only two classes of tenants recognised by the law were those who held of the king, or mesne lords, by pure villenage, or absolute and base service; and by villein socage, which was also a base service, but restricted to certain specified duties. From the tenure of pure villenage have sprung our present copyhold tenures; by which certain lands are held within *manors* (which are the old estates held in early times directly of the king) by the *will of the lord*, as it is expressed in their grant, although by long usage the will of the lord is merely nominal, and the obligations of the tenant consist only in certain specified rents and services.

The object of the statute Quia Emptores was to restrain the creation of fresh subordinate estates, by declaring that if anyone alienated his land by sale or feoffment (which purported to convey it in perpetuity) the feoffee should hold the same, not of the feoffor, but of the feoffor's lord, whether a mesne lord or the king himself. Hence all manors must have existed prior to the reign of Edward I.; as it is essential that there should be in them tenants who hold of the lord, and such tenancies could not have been created at a later period.

When alienation of lands and tenements was made in early Norman times, the alienation was either to the donee and his heirs for ever—thus giving him an absolute unrestricted property, descendible to his heirs, whether male or female, subject only to his homage to the donor; in other words, a *fee simple*; or it was upon condition—as, for instance, a grant to a donee, provided he had issue; under which grant, if the donee died without issue, or his issue came to fail, the land would revert to the donor. The conditional donees had devised, with the assistance of the king's judges, various ingenious methods of defeating these provisions; as by aliening as soon as they had issue, and then repurchasing the fee simple. It was to fix the law of conditional gifts that the statute De Donis, 13 Edw. I., was passed; by which such a donee was absolutely prevented from aliening the tenements. Hence arose *estates in fee tail*: in other words, estates granted to a man and to certain specified heirs; for example, the heirs male of his body. In after times, when the restraint on alienation which this statute created began to be repugnant to the more liberal feelings of the people, certain devices were invented (fines and recoveries), whereby the donee in tail was enabled to bar the entail and acquire the fee simple, as he could have done before this statute was passed.

Besides these famous statutes, we find the reign of Edward I. distinguished by the confirmation of Magna Charta and the Charter of Forests. The first of these great constitutional acts contains few provisions of much importance in legal history, and was far more valuable as an evidence of the spirit of the country in restraining arbitrary usurpations, than, as is commonly supposed, by establishing any new franchises, or even confirming ancient ones. Perhaps its most important legal effect was the fixing to the city of Westminster the Court of Common Pleas, which had formerly caused the suitors much inconvenience by following the person of the king in his numerous progresses.

It is also to the reign of Edward I. that we must refer for the distinct definition of the province of that court, and of the other two superior common law courts of record, the King's Bench and Exchequer. The history of these three courts is far too intricate, and requires too much explanatory statement, to find a place in these pages. It must suffice to observe, that the King's Bench is the ancient Aula Regia, in which the king was supposed, as by fiction of law he still is, to sit in person, and which followed him in all his progresses, insomuch that in the reign of Edward I. it actually sate in Scotland. [KING'S BENCH.] The Court of Common Pleas, or Common Bench, had in strictness jurisdiction in all civil causes between subject and subject. In this court only real actions, in which the right to land is tried—now almost all abolished [REAL ACTION], but anciently the most important part of judicial business—could be adjudicated. The Court of Exchequer was intended to recover the king's debts and ordinary revenues of the crown. It acquired in process of time a jurisdiction over common personal actions, by the fiction of the complaining party being a debtor to the king; and also an equitable jurisdiction, similar in form to that of the chancellor's court.

The equitable jurisdiction of the chancellor had probably begun long before the reign of Edward I. [CHANCELLOR], and before his reign the original writs, by which actions were commenced, had been sued out or obtained in the chancery, the clerks of which, like the pontifical framers of the *actiones* among the Romans, had the monopoly of drawing up these magical instruments. In the reign of Edward I. (by Statute of Westminster the Second, 13 Edw. I.) an important change was made in this branch of law, by authorising the clerks to frame writs adapted to particular cases which the old forms did not adequately suit. Hence originate our modern actions of *trespass on the case*.

From the same statute the modern judges of *assize* and *nisi prius* [Nisi Prius] are chiefly derived. These were originally occasional commissioners sent down into the counties to deliver the gaol of prisoners, or to try civil causes. By this statute the commission was first directed to be given to the king's justices, associated (as they still are in form) with one or two discreet knights of the county. The commission of assize is, strictly speaking, a commission to try disputes respecting land wherein the writ of assize (which dates, as before stated, from Henry II.) was brought—now fallen into disuse. The commission of *nisi prius* originates in what may now be called a legal fiction. When the pleadings in an action in the superior courts [Pleading] are concluded, and an *issue of fact* is taken between the parties, the issue is appointed, by the entry on the *record* or written proceedings, to be tried by a jury from the county in which the proceedings arise, at Westminster, *unless before* the day appointed (*nisi prius*) the judges shall have come to the county in question. Besides these commissions, the same judges try criminal cases by virtue of a *commission of the peace*, in which they are associated with the justices of the county; a commission of *oyer and terminer*, to hear and determine all treasons, felonies, and misdemeanours; and a commission of general gaol delivery, to try and deliver every prisoner who shall be in the gaol at their arrival in the county.

Having referred to the reign of Edward I. as the period under which a general sketch of our old common law might be most advantageously presented, we proceed to notice very briefly the chief alterations which mark its subsequent history. These alterations can be easily ascertained where they were caused by the highest legal authority—by the parliament of the nation. But far greater changes have been wrought by the silent course of the tribunals—by the discretionary power which our judges have assumed to extend the remedies, which they were authorised to administer, to cases unprovided for by earlier law, which either the ingenuity of practitioners, or, in many more instances, the increasing wants and more intricate relations of life, had called into existence. To trace such alterations is as impossible as to note, day by day, the increase of stature by which the child grows into the man. Often, in laboriously investigating the history of our English jurisprudence, we are surprised when we look back, after perusing the events of a generation or a century, to the state of things as it existed at the beginning of that epoch, and find that although we cannot with all our diligence detect in its history the occurrence of any external changes in the subject on which our minds are fixed, yet the same forms, the same modes and circumstances, present themselves to our eyes under a totally different aspect and character.

The reigns of Henry II. and Henry III. are principally remarkable for the gradual substitution of the king's justices of the peace for the various elective magistrates who exercised the several duties of that office before. It was in the reign of the latter prince also that the parliament is supposed to have finally acquired its present form. Under the successors of the Edwards, and during the wars of the fifteenth century, small accessions were made to the general bulk of English law; but during those times very great changes were silently taking place in the disposition of property by means of the invention of Uses, borrowed from the civil law. This extensive and most important subject will be found briefly treated of under the head of Chancellor.

The laws of Henry VII. had principally in view the benefit of his exchequer. Under his successor, whose reign forms so important an epoch in political history, the laws of property were very considerably modified by the two statutes of Uses and of Wills. [For the former, see Use.] The latter rendered general the power of devising estates by will. The system of bankrupt laws also had its commencement under Henry VIII. His daughter Elizabeth did not add much to the essential and valuable parts of our statute book; but under her government the Acts which restrained the alienation of lands by ecclesiastical bodies were passed, and also the celebrated statute respecting the poor, of which the policy forms, even at the present day, a subject of some controversy. In the succeeding century, the reign of James I. witnessed the first attempt to limit the period at which actions and suits might be commenced; and the first statute of bankruptcy. But it is most remarkable for the laborious attempt to systematise our ancient law by Sir E. Coke, one of the most acute if not philosophical jurists of any age or country. That of Charles II. forms the next marked epoch in the history of our law, after those of Edward I. and Henry VIII. His restoration was distinguished by the abolition of feudal tenures and incidents, and the reduction of all the modes by which estates of inheritance might be held (with few exceptions) to two only, freehold and copyhold. The Statute of Frauds, a necessary protection, perhaps, to unwary transactors of business, but a source of endless litigation; the statute which regulates the distribution of the effects of intestates; and finally, the celebrated Habeas Corpus Act, which gave, or rather confirmed, to every person imprisoned by any authority short of the express and definite course of justice, the means of releasing himself—are all productions of this reign.

The eighteenth century, while it gave rise to new views and widely extended discussions on jurisprudence, did not in England produce much substantial alteration by statutory enactment. It was rather a period of preparation for change, in the political as well as the legal world, than of actual reform. But it was distinguished by the learning and acuteness of several judges who occupied the seats of justice during many years, and introduced by the slow

exertion of their own authority a new spirit into institutions of which the forms were preserved.

But the present century has been emphatically a period of legal reform: and some at least of the great changes effected may be studied under the heads LAW, CRIMINAL; PLEADING; ECCLESIASTICAL COURTS; BANKRUPTCY; and so forth.*

The term *common law* is ordinarily employed in two different senses. In its legal signification it expresses the old unwritten law, established by precedent and custom; comprising, it has been said, 'all recognised doctrines and customs, however introduced, which are neither to be found in the statute book, nor depend on the adjudication of courts of equity.' For this floating mass of legal principles our ordinary sources are precedents, or decisions of common law judges, as contained in published reports. Where these fail us, reference may sometimes be had to more uncertain guides, the dicta of legal writers, or the general principle and tendency of our laws, for authority in deciding a particular dispute.

In its popular sense, common law is opposed to equity and ecclesiastical law; and thus comprises the whole of that law, both criminal and civil, which is administered in courts having trial by jury, and all the other subjects which are within the purview of the common law courts of Westminster Hall, and of the various local jurisdictions of the country (except so far as some of them exercise equitable authority). It has been defined to be 'the whole of that code, whether founded on statute, usage, or precedent, which is now administered in the common law courts of Westminster Hall;' and this definition will comprehend the law administered in the various local courts in question, as these are bound to act on the decisions of the superior courts. Its peculiar characteristic is, that questions of fact arising out of its proceedings are submitted to the decision of a jury.

It is, perhaps, not very easy to assign either the history or the theoretical principles of the separation of equity from common law. The former was undoubtedly in the first instance a jurisdiction of a remedial character, intended to moderate, according to the conscience of the judge, the rigour of legal judgments; but this is a peculiarity which can scarcely be said to distinguish it in the present day. Its rules are as accurately laid down by precedents as those of the common law itself; but there are some subjects (as trusts) which, having been created in frustration of the provisions of the common law, are out of its cognisance. Over these courts of equity have an *exclusive* jurisdiction. There are others over which both equity and law have *concurrent* jurisdiction. But the remedies applied by law to injuries committed are subject to certain inflexible rules. The power of a jury has limits from the very nature of the institution. It can award a debt sought to be recovered, or damages for an inju- ; but it cannot modify the remedy according to peculiar circumstances. Nor has it any means enforce a course of action other than by posing damages for neglecting it. To take familiar instance: If A sues B at law for breach of covenant, and judgment passes in favour of A, all that a jury can do is to award damages to A for the breach of contract; but equity can, by a process of its own, compel B to a specific performance of the contract under the penalties attached to a contempt of court. So, if one of several joint contractors be liable, at law, for penalties or debts incurred in respect of their joint undertaking, his only legal remedy is by an action against each; in equity, he can compel each of his partners to contribute to the extent of their liability.

Law, Criminal, of England. Some account of various portions of this important and extensive subject will be found under the appropriate headings throughout this Dictionary. But the extensive consolidation of the criminal law effected by the Acts of Parliament of 1861 (24 & 25 Vict.) renders a brief synoptical view of it more attainable than before that time it could have been.

Offences are punishable by INDICTMENT or INFORMATION [which see], or, in minor cases, under many Acts of Parliament, by summary conviction.

For the distinction between FELONIES and MISDEMEANOURS, see those heads respectively.

The mode of compelling appearance is by summons or warrant (now regulated by 11 & 12 Vict. c. 42); the latter being granted, in the first instance, in felony, and in many misdemeanours.

The party accused being arrested under the warrant (or bailed where bail is admitted), or having appeared to the summons, is charged by indictment before the grand jury. [JURY.] The grand jury having found a true bill against him, at assizes or sessions, the prisoner is put to the bar to answer it, which is termed *arraignment*. If he is at this time not of sane mind, the jury, on finding him so, may cause his commitment for safe custody at the pleasure of the crown. If otherwise, he answers the indictment either by demurring to it as bad in law, or by pleading. The result of a successful demurrer is that the indictment is *quashed*; but this, since the modern improvements in the law, is of rare occurrence. Pleading may also be *in abatement* or *to the jurisdiction*, raising issues of law, but these are also now almost reduced to nullities. Pardon, and former acquittal or conviction of the same offence, may also be pleaded. But the ordinary plea is *guilty* or *not guilty*; and on the latter, the issue of the prisoner's guilt being raised, the trial proceeds before the jury; as to the ordinary incidents of which, see JURY.

Offences are now ordinarily divided as follows:
1. Against the queen and her government.
2. Larceny and other cognate offences (embezzlement, burglary, &c.), the law as to which is consolidated by the Larceny Act, 1861.
3. Malicious Injuries to Property (Act, 1861).

4. Cheats, Frauds, and Forgeries (Forgery Act, 1861). 5. Offences relating to the coin (Coinage Offences Act, 1861). 6. Offences against the person (Act, 1861). To which may be added various classes of misdemeanours and offences not embraced by the statutes of that session; offences against public justice; perjury, conspiracy, and extortion; offences against the public peace, religion, and morals; against public trade (now nearly obsolete); against the public revenue; nuisances; and the like. (See the arrangement in Woolrych's *Criminal Law*, as amended by the statutes of 1861.)

The affirmation or denial by the jury of the guilt of the prisoner is termed their *verdict*. The many technical modes of escape for a prisoner, which formerly existed from imperfect or irregular verdicts, have now been nearly got rid of by the enactments that, on a trial for felony or misdemeanour, the jury may in all cases find the prisoner guilty of *an attempt*, if they are not satisfied that the offence was fully committed; and that, if on trial for a misdemeanour the party shall appear to have been guilty of a felony, he shall not be entitled to acquittal.

The effect of acquittal is to discharge the prisoner of all future charges in respect of the same offence.

The verdict of *guilty*, having been given, may be impeached by a motion to arrest the judgment, for errors of law *on the face of the record*. In misdemeanours, not in felonies, except in some special cases, a new trial may also be obtained on ground of miscarriage at the former trial. If the verdict be unimpeached, conviction and judgment follow. The punishments now in force for offences are: fine; corporal punishment in a few cases; imprisonment; PENAL SERVITUDE; TRANSPORTATION [see those two arts.]; and death. The profuse employment of capital punishment was the opprobrium of the English code, even down to the commencement of the present century. It is now confined to cases of high treason and murder.

By the Act 11 & 12 Vict. c. 78 (1849), criminal courts throughout the country were authorised to reserve any question of law which might arise on the trial (in the event of conviction) for the judgment of a criminal appeal court, composed of the judges of the superior courts at Westminster, or five of them at the least, who may affirm, reverse, or amend the judgment.

Law, Grimm's. In Comparative Philology. [LANGUAGE.]

Law, Maritime. [MARITIME LAW.]

Law, Martial. This phrase, which has no definite legal meaning, is used to express the suspension of ordinary, and the substitution of arbitrary, tribunals for the trial of criminal and (if need be) civil cases, by the authority of the crown, sanctioned by statute, in emergencies of rebellion, invasion, or insurrection. It is usually carried out by putting under the cognisance of courts martial a great variety of subjects which by ordinary military law do not appertain to them, to be tried in a summary way. The statute for putting into execution martial law usually gives a power to arrest and detain in custody all suspected persons, and to cause them to be brought to trial in a summary manner by courts martial, and to execute the sentence of all such courts, whether of death or otherwise; and declares, that no act done in consequence of these powers shall be questioned in any of the king's ordinary courts of law, and that all who act under the statute shall be responsible for their conduct only to such courts martial.

Law, Military. This term denotes properly that law which is administered by courts martial to soldiers, under the authority of parliament and the Mutiny Act, annually passed, together with the Articles of War. (Simmons *On Courts Martial*; Pipon's *Manual of Military Law*.) [COURTS MARTIAL.]

Laws of Chemical Combination. [EQUIVALENTS, CHEMICAL.]

Laws of Gaseous Diffusion. [GASES, DIFFUSION OF.]

Laws of the Twelve Tables. [DECEMVIRI.]

Lawn (Fr. linon). A fine variety of cambric, formerly exclusively manufactured in Flanders. Of late the lawn manufacture of Scotland and of the north of Ireland has been brought to rival that of the Flemish weavers.

LAWN (apparently the same as Dutch laen, Fris. lana, Welsh llan). In Gardening, a surface of grass or turf in pleasure grounds kept smoothly mown.

Lawsonia (after Dr. Isaac Lawson). A genus of *Lythraceæ*, yielding the famous Henna of the East. The plant *L. alba*, sometimes called *L. inermis*, is a dwarf shrub with privet-like leaves, which in the powdered state are used as cosmetics throughout the East, for dyeing the finger and toe nails, the tips of the fingers, the palms of the hands, and the soles of the feet, to which it imparts a reddish orange colour, considered by women as greatly enhancing their beauty. The men use it for colouring their beards. When used, the powder is made up into a pasty mass, and spread on the part to be coloured.

Laxatives (Lat. laxativus, from laxare, *to loosen*). Gentle aperient medicines, opposed to *cathartics*, which are drastic purgatives. Laxatives merely evacuate the contents of the intestines without occasioning any general excitement, or even stimulating the exhalant vessels of the canal. [CATHARTIC.]

Lay (Prov. lais, A.-Sax. lioth, Ger. lied). The lyric poems of the old French minstrels, or trouvères, were termed *lais*; but the title in modern usage is given to narrative poems of moderate length in simple style and light metre.

LAY. In Agriculture. [LEA.]

Lay Brothers. Persons received into convents of monks, under the three vows, but not in holy orders. The introduction of this

class of devotees appears to have begun in the eleventh century. They are dressed somewhat differently from the other monks or *brothers of the choir*, and often employed in the manual exercises necessary for the uses of the community. The Carthusian and Cistercian orders are said to have first recognised the distinction, and their example was followed by the other orders. The same distinction exists in monasteries of females between the nuns properly so called and the lay sisters, or sisters converse.

Lay Elders. In Presbyterian churches, ministers with ecclesiastical jurisdiction, not ordained as clergymen, who assist the pastor in each congregation. [PRESBYTERIANS; KIRK.] The divines of that persuasion rest the appointment of lay elders in some measure on that of presbyters 'in every city' by Paul and Barnabas, who, they imagine, from the manner in which they are mentioned, could not have been all preachers. (Hooker, *Eccl. Pol.* b. vi.)

Layering. In Gardening, a mode of propagating plants by laying down shoots, and covering a portion of them with soil, so that the extremity of the shoot is left above ground, and the shoot itself not detached from the plant. In order to facilitate the rooting of such shoots, called *layers*, the portion buried in the soil is fractured by twisting or bruising, or cut with a knife immediately under a bud. This operation, by obstructing the return of the sap from the leaves, occasions its accumulation at the wounded part, when roots are there produced from the effort of nature to perpetuate life.

Laying. In Architecture, the first coat, on lath, of plasterer's two-coat work, the surface of which is made rough by sweeping it with a broom, to form a key for the next coat; the difference between the laying and the rendering coats being, that the latter is the first that is applied on a brick or other wall.

Laying Off. In Shipbuilding, this term denotes the developing in thin wood, on the mould loft floor, from the construction drawings, a section (actual size) of any part of the timbers of an intended ship.

Laying a Piece of Ordnance. In Gunnery, pointing a piece of ordnance so that the projectile may strike the required object. [GUNNERY.]

Layman (Gr. λαϊκός; from λαός, *people*). The appellation by which the rest of the community are distinguished from the clergy or the members of a profession, as of medicine, the bar, &c. [LAITY.]

Layman, or *lay-figure*, among painters signifies a small statue, whose joints are so formed that it may be put into any attitude for the purpose of adjusting the drapery of figures.

Lazar House or **Lazaretto** (Ital.). A public building in the southern European states, of the nature of an hospital, for the reception of the poor and of persons afflicted with contagious disorders. In some places lazarettos are set apart for the performance of quarantine; in which case only those are admitted who have arrived from countries infested by the plague, or suspected of being so. Howard's well-known account of the principal lazarettos of Europe furnishes the most detailed and interesting particulars of these establishments.

Lazarists. In Ecclesiastical History, a body of missionaries founded by St. Vincent de Paul in 1632; so termed from occupying the priory of St. Lazarus, at Paris, as their head-quarters. Their primary object was to dispense religious instruction and assistance among the poorer inhabitants of the rural districts of France. They were dispersed at the time of the Revolution, but have been since re-established.

Lazarus, St., Order of. A military order of religious persons, originally an association of knights, for the purpose of maintaining lepers, &c. in lazar-houses or hospitals, especially in the Holy Land. Being driven out of Palestine in 1253, they followed St. Louis to France. In 1490, their order was suppressed by Pope Innocent VIII., and united with that of St. John; but the bull was not universally received. In 1572, they were united in Italy with the order of St. Maurice; in 1608, in France, with that of Our Lady of Mount Carmel. The knights of these united orders were allowed to marry.

Lazulite (Arab. azul, *heaven*, and Gr. λίθος, *stone*). The name applied by Haüy and some other mineralogists to LAPIS LAZULI [which see]. By Werner, Dana, and others, the term is applied to a hydrous phosphate of alumina and magnesia from Styria and the Tyrol. It generally occurs granular or massive of various shades of azure-blue, inclining to green or white, and is distinguished from Lapis Lazuli by never being accompanied by Iron Pyrites.

Lazzaroni (Ital.). A name given to the poorer classes at Naples, from the Hospital of St. Lazarus, which served as a refuge for the destitute in that city. Forty years ago two large sections of the people were generally comprehended under this name—the fishermen, and the lazzaroni properly so called, who lived in the streets, and performed no labour but that of errand porters and occasional servants. These alone were estimated at 40,000, and formed a powerful community, which under Masaniello accomplished the revolution of Naples, and, in later times, overthrew the popular government, under the influence of Cardinal Ruffo and the English party. But during the French occupation of Naples they ceased to exist as a distinct class; and the name is now only used to designate in general language the mob or populace of that city.

Le Roi le veut (Fr. *the king wills it*). A form of words by which the royal assent is intimated by the clerk of parliament to the passing of public bills. To private bills the royal assent is expressed by *Soit fait comme il est désiré*. The dissent of the sovereign to the passing of any measure is signified by the words *Le roi s'avisera*. [PARLIAMENT.]

In Agriculture, a term applied to lands which are kept under grass or pasturage for a short period. For example, in a rotation of fallow, wheat, clover and rye grass, for three years. The ground, when under clover and rye grass, is said to be in lea.

Lead (Dutch lood). A metal of a bluish-grey colour, known from the earliest ages: the alchemists gave it the name and symbol of Saturn ♄. Its specific gravity is 11·38. It is soft, flexible, and inelastic; and though ductile and malleable, is possessed of little tenacity. It fuses at about 600°; and if air be carefully excluded, it does not appear to be volatile at a white heat. When melted in open vessels, it soon changes into a grey powder, which upon further exposure to heat and air becomes yellow, and is called *massicot*; or, when partially fused, so as to assume a scaly form, *litharge*. If massicot be heated, and stirred to prevent fusion, it gradually absorbs oxygen, acquires a red colour, and is called *red lead*. When red lead is heated in nitric acid, it is partly dissolved, and partly converted into a brown powder, which is insoluble, and is a *peroxide of lead*. Massicot, or the yellow oxide of lead, is the *protoxide* (PbO), and that which forms the salts of this metal: it is constituted of 1 atom of lead = 104, and 1 of oxygen = 8, and its equivalent is 112. The brown peroxide consists of 1 atom of lead and 2 of oxygen (PbO_2); and red lead is intermediate between the two extremes, consisting probably of an indefinite mixture of the two oxides. The protoxide of lead is soluble in the greater number of the acids, and forms a variety of salts; of these the carbonate and the acetate are the most important. *Carbonate of lead* (PbO, CO_2), or, as it is commonly called, *white lead*, is the basis of white oil paint, and consequently of a number of other colours: it may be prepared by exposing sheet lead to the fumes of vinegar, by which it is gradually corroded, and its surface becomes covered with an incrustation, which, when scraped off and well levigated, is white lead. [CERUSE; WHITE LEAD.] This article is also made by precipitating a solution of acetate of lead by carbonate of soda; it consists of 112 oxide of lead and 22 carbonic acid. *Acetate of lead* ($PbO, C_4H_3O_3$) is made by dissolving carbonate of lead in acetic acid, for which purpose the pyroligneous vinegar is chiefly used. It crystallises in six-sided prisms, but is generally met with in confused crystalline masses. It is soluble in about 4 parts of cold water, and the solution has a remarkably sweet taste; whence the term *sugar of lead*, usually applied to this salt. It consists of 112 oxide of lead and 51 acetic acid. The crystals include 3 atoms of water, and are therefore represented by the equivalent 190; or 163 dry acetate and 27 water. When protoxide of lead is boiled in distilled vinegar, or in a solution of acetate of lead, a dense solution of subacetate or *triacetate* of lead is obtained: it is not easily crystallisable. This solution is often used in the chemical laboratory as a test and precipitant and it forms the *extract of lead* (*Goulard's extract*) of pharmacy.

The most important native combination, or *ore of lead*, is the *sulphide*, composed of 104 lead and 16 sulphur. It is the *galena* of mineralogists, and from it the commercial demands for lead are supplied: it is roasted to expel sulphur, and the lead thus oxidised is reduced by heating with charcoal. [GALENA.]

The action of water upon lead is curious and interesting, in consequence of the universal use of leaden water pipes, and of water cisterns lined with this metal. Perfectly pure water, such as distilled water, put into a clean leaden vessel and exposed to air, soon corrodes it, and delicate tests discover oxide of lead *in solution* in the water; but river and spring water exert no such solvent power: the carbonates and sulphates in such water, though in very minute quantities, prevent the action. Hence it is that leaden cisterns are used with comparative impunity for the preservation of common water, and that the crust which forms upon the metal prevents further action. As this crust partly consists of carbonate of lead, which is very poisonous, great care should be taken to prevent its *diffusion* through the water upon any occasion, as by scraping or cleaning the cistern. Leaden cisterns also sometimes prove injurious in consequence of galvanic action, where iron or zinc pipes are soldered or let into them: the lead is thus rendered electro-negative, alkaline matter is evolved upon it, and small quantities of the oxide or carbonate are thus rendered soluble. There are several re-agents by which very minute quantities of lead may be detected. Among these, solution of sulphuretted hydrogen is perhaps the most effective: it produces a brown tint in water containing the minutest trace of lead, and it similarly discolours the greater number of the insoluble salts of the metal. A solution of sulphate of soda is also a sensible test of the presence of dissolved oxide of lead; it forms a white cloud in water containing the smallest traces of it: a fragment of iodide of potassium dropped into such water presently occasions in it a yellow tint, in consequence of the formation of an iodide of lead.

Lead, Black. [PLUMBAGO.]

Lead Glance. Native sulphide of lead. [GALENA.]

Lead of a Slide Valve. The small space which is left open at the end of each stroke of the piston, on the opposite side of the movement, to admit the steam, for the purpose of checking the speed of the piston, and of facilitating the opening of the valve for the reverse motion.

Lead for Sounding. The common hand lead weighs from 7 to 11 lbs., and is used with about 20 fathoms of line. The leadsman stands somewhere on the side of the vessel, usually in the channels; lets the lead descend near the water; then, swinging it over his head once, or twice if the ship is going fast, throws it forward. The line is marked at 5, 7, 10, 13, 17, and 20

fathoms. The numbers between are called *deeps*, or more properly *dips*; the meaning being that in the absence of a mark the leadsman estimates by the dip of the line; thus, *by the mark* 7, *by the deep* 9, indicate 7 and 9 fathoms.

When the depth is great, the deep-sea lead of 25 to 30 lbs. is used, with a much longer line marked at every 10 fathoms. The lead is dropped from the fore part of the vessel, being thrown as far as possible in the line of the ship's drift. To make the sounding fairly vertical, it is desirable to heave the ship to.

Lead Spar. Native carbonate of lead. [Cerusse.]

Leads or **Space Lines.** Pieces of type metal cast to specific thicknesses and lengths, lower than types, so that they do not make any impression in printing, but leave a white space where placed. Their general use is to be placed between the lines when a work is not closely printed (this being considered to look better than when printed solid), and also to branch out the heads of pages and titles.

Leaders. [Newspapers.]

Leadhillite. Native sulphate and carbonate of lead, found crystallised with other ores of lead at Leadhills in Scotland.

Leading Note. In Music, the sharp seventh of the scale, so called because it naturally leads to the key-note.

Leading Wind. A Nautical term for a full fair wind.

Leaf (Ger. laub). In Botany, an expansion of the bark at the base of a leaf-bud, prior to which it is developed, its functions being at once those of respiration, digestion, and nutrition. It is a plate of parenchyma, through which spiral vessels and woody tissue ramify. Its surface is covered with stomates, which communicate with minute hollow chambers in the interior. It is in the leaf that most of the peculiar secretions of a plant are prepared out of the crude sap which the roots obtain from the soil.

Leaf-buds. In Botany, rudiments of young branches, made up of scales imbricated over each other, the outermost being the hardest and thickest, and surrounding a minute axis, which is in direct communication with the woody and cellular tissue of the stem. When stimulated by light and heat they extend into branches; or if artificially removed from the plant that bears them, they are capable of multiplying the individual from which they have been taken.

Leaflet. In Botany, a small leaf formed by the petiole of a leaf branching out, and separating the cellular tissue of the lamina into more than one distinct portion, each of which forms a perfect lamina of itself.

League (Low Lat. leuca; Fr. lieue: Mr. Wedgwood connects the word with Gael. leug, leug, *a stone*, as used to mark the distances between places). A measure of length, used in reckoning distances by sea. The sea league is three nautical or geographical miles, or the one-twentieth of a degree, and consequently about 3·45 English miles.

The common land league is a well-known itinerary measure on the continent of Europe, chiefly in France. The French, however, have two distinct leagues: the legal posting league (*lieue de poste*), containing 2,000 toises, and equal to 2·42 English miles; and a league of 25 to the degree (anciently the *lieue moyenne*), or equal to about 2·76 English miles. It is supposed that the league, or *leuca*, was introduced into England by the Normans, where at an early period it came to be reckoned as equivalent to two miles of the time; this being the sense in which the term *leuca* is used by the oldest law writers, and in most of the old English charters. [Mile.]

League (Fr. ligue, Ital. legua, from Lat. ligare, *to bind*). In Politics, a league appears to be in strictness an alliance between two or more powers, in order to execute some common enterprise. It is, therefore, more active and less durable than an alliance or a confederacy; both of which have some permanent object, while neither necessarily requires active co-operation. In the middle ages, the word *league* was used nearly in the sense now attached to these latter terms; hence we read of the Hanseatic League, and of the three leagues once subsisting in the canton of the Grisons in Switzerland; both of which were more properly confederacies.

League, The Holy, or simply **The League.** In French History, a political association formed by the Roman Catholic party in France under the reign of Henry III. The project of the League is said to have been framed by one David, an advocate; or, rather, he first conceived the idea of uniting the separate associations of the Catholic party in the provinces into one great confederacy. His written scheme bears date 1575. It was received with eagerness, especially by the municipality and citizens of Paris and other large towns. The object of the League was at first only the overthrow of the Protestant power: but the princes of the house of Guise soon placed themselves at its head, and the leaders of the party were not slow in adopting the project of changing the succession, and placing the duke of Guise on the throne. In 1588, the citizens, under the impulse of the League, drove Henry III. from Paris on the Day of the Barricades, and formed the revolutionary government of 'the Sixteen.' But after the death both of the duke and the king, much division arose in the head-quarters of the League at Paris as to the choice of a successor; and in 1591 the popular party, or that of the Sixteen, was put down by the citizens: which event in effect destroyed the power of this great association, although it still continued to exist, even after the abjuration of Henry IV.

League, Solemn. [Covenant.]

Leakage (Dutch lekken, *to drip*; the same root is found in the Latin liquare, *to filter*). In Commerce, an allowance in the

customs granted to importers of wine for the waste and damage which the goods are supposed to receive by keeping.

Lean-to. In Architecture, a building whose rafters pitch against or lean on another building.

Leap-year or Bissextile. A year containing 366 days. In the Gregorian calendar this occurs every fourth year, excepting years which complete centuries; in which case the intercalary day is omitted, unless the number of the year is divisible by four. [CALENDAR.]

Lease (akin to Fr. laisser, Ger. lassen, *to let*). In Law, a lease is properly a conveyance of lands and tenements (usually in consideration of rent or other annual recompense), made for life, for years, or at will, but always for a less time than the lessor or party letting has in the premises. The usual words of operation are, 'demise, grant, and to farm let.' The conveyance by a lessee of part of his interest is properly an underlease; of the whole, an assignment.

Lease and Release. In Law, a mode of conveyance appropriate to freehold estates, arising out of the ancient principles of the law of real property, whereby a release was the appropriate instrument to vest the freehold in one already in possession under a lease. It was generally adopted in conveyancing as the most convenient mode of transfer, but is now dispensed with by recent enactments, particularly 8 & 9 Vict. c. 106 s. 2.

Least Squares, Method of. [MINIMUM SQUARES.]

Leather (Ger. leder, Welsh lledr). The prepared skins of animals. The principal object of the art of converting skin into leather is to render it strong and tough, durable, and often waterproof, and to prevent its destruction by putrefaction. The skins are first cleansed of hair and cuticle, and then impregnated either with vegetable tan, as in the production of what is called *tanned* leather, or with alum and other salts, as for *tawed* leather; these processes are sometimes combined, and tanned leather often undergoes the further operation of *currying*, or impregnation with oil. As instances of these different results, thick sole leather is tanned; white kid for gloves is tawed; the upper leather for boots and shoes is tanned and curried; fine Turkey leather is tanned with shumac.

A skin does not consist of gelatine, as hitherto supposed, for gelatine is soluble in water, and a hide or skin is not. What was supposed to be gelatine is an isomeric substance named *ossein*. In the usual method of tanning, ossein passes into gelatine by a slow putrefactive process, and this combines with the tannin. To render tanning a quicker process, some method is wanted of converting ossein rapidly into gelatine.

Tanned Leather.—For thin skins which are afterwards curried, the hide is cleansed, and soaked for a day or two in water; it is then *beamed*, or stretched upon a half-cylinder of wood, where it is cleared of adhering fat and flesh; it is then soaked for several days in a pit of lime and water, by which the hair and cuticle are so far loosened as to admit of being scraped off upon the beam; the hide is then washed and put into the *grainer* pit, which is a mixture of water and dung—that of hens, pigeons, or dogs being preferred. When the hide has here become soft and supple, it is again thoroughly cleaned, and submitted to the tanning liquor, which is at first used very weak, and gradually strengthened till the operation is complete: this requires from two to four months for calf skins, and from ten to twelve months for ox hides, with oak bark, but a much less time if gambia is used; and the latter hides, instead of being limed and dunged, are generally, after having been cleaned in water, placed in heaps, where they begin to putrefy, and then the hair may be removed without lime, which would be apt to render the skin hard and harsh. The further opening of the texture, so as to prepare it for tanning, is effected by immersion in a sour liquor of fermented rye or barley, or in weak sulphuric acid. This process is called *raising*, and immediately precedes the tanning. When fully tanned, the goods are drained, stretched upon a convex piece of wood called a *horse*, and beaten and smoothed; or the leather is sometimes passed between cylinders to make it more solid and supple: it is lastly dried, by suspension in an airy covered building. It will be obvious [TAN; GELATINE] that the principal change effected in this process depends upon the combination of the gelatine of the skin with the tannin of the oak bark, or other astringent material which is used, and that great care is requisite to insure the perfect penetration of the hide (especially where it is thick) by the tanning material: hence the necessity of using weak liquors at first, and gradually increasing their strength; for if the hide were in the first instance put into a strong infusion of bark, the exterior surfaces would become so perfectly tanned as to be impervious to the further action of the liquor, and the centre would remain untanned, and consequently soluble and putrescible; so that we judge of the completion of the process by the leather, when cut through, being of a uniform brown throughout, anything like a white streak in the centre announcing the imperfection just mentioned.

Tanned Sheep Leather, &c.—The skins are first soaked for a few hours in a water pit, then well washed and painted with milk of lime on the flesh side, and hung in a warm room till the wool readily pulls off; they are then scraped, and soaked for some weeks in lime water, which checks the putrefaction and hardens the texture; the skin is then again beamed, smoothed, and trimmed, and put into a vat of bran and water, where it is kept for some weeks in a state of gentle fermentation, and becomes thin and extensible, and fit for any subsequent operation: in this state it is called a *pelt*. The pelt is placed in a lime pit for two or three weeks, according to the season of the year, then fleshed and trimmed

on a beam; if intended for skiver leather, the pelt is split into two parts, the grain side for leather, and the flesh side for parchment or chamois. For the first branch, the grain has to be pressed in a grainer, to remove all lime, hair, and cuticle; then placed in a drench, made of bran and water, for twelve hours; after which it is ready for tanning in shumac. For tawed leather, the pelt is not split; the preparing process is the same, but the tanning is done with alum and salt. The method of bringing kid and calf skin to the state of pelt is nearly the same as for lamb skin, except that liming is used before the hair is taken off, which is only sold to plasterers, whereas lambs' wool is more valuable, and would be injured by the lime. If the pelts are to be tawed, they are worked about in a solution of alum and salt in warm water, which again makes them thick and tough; they are then washed and again fermented in bran and water till the thickening is reduced by the removal of some of the salts; lastly, they are stretched on hooks, and dried in a stove room, when they become a tough flexible white leather; but to give them gloss and suppleness they are again soaked in water, and trodden in a large pail or rolled in a drum containing the yolks of eggs beaten up with water; they are next dried in a loft, smoothed with a warm iron, and afterwards softened on a stake, when they are dyed with various colours for gloves and ladies' boots.

Morocco leather, as it is called, is chiefly prepared from goat skins, which after the action of lime water are brought down by a dung bath, and reduced to the state of pelt. If intended to be dyed red, they are sown up in the form of a sack, with the grain side outward, and immersed in a warm cochineal bath; the sack is then tanned in a bath of sumach: the skins intended to be blacked are sumached without any previous dyeing. The graining and polishing are effected as follows: The skins are stretched upon a smooth inclined board, and rubbed over with a little oil to supple them. Those intended for black leather are previously brushed over with a solution of iron; they are then rubbed over with a glass ball cut into a polygonal surface, which polishes them, and makes them firm and compact; lastly, the grained surface is given by rubbing the leather with grooved boxwood rollers fitted to a machine, called a *jigger*, suspended from the ceiling. *Curried leather* is tanned, and then softened by soaking in water and rubbing; it is pared with a broad sharp knife, the edge of which is turned over so as to be at right angles to the plane of the blade; the leather is next rubbed with a polished stone, and while still wet besmeared with fish oil, or a mixture of this with tallow. As it dries, the oil gradually penetrates in proportion as the moisture evaporates. The grain side is blackened by iron liquor for the uppers of ladies' shoes, but the flesh side with lampblack and oil for the uppers of men's boots and shoes.

Shammoy leather is generally sheep or doe skin, prepared as already mentioned by dressing, liming, &c., and dyed if necessary, and then finished in oil. *Russia leather* acquires its peculiar odour from an empyreumatic oil from the bark of the birch tree. (There is an excellent abstract of the manufacture of different kinds of leather in Aikin's *Dictionary of Chemistry*, from which much of the above is abridged.)

American leather cloth, or *panonia leather*, is an artificial compound variously prepared. In one example, a textile fabric is impregnated with oak bark and gelatine for forming leather, and stearic acid and an alkali for forming a kind of insoluble soap. A flexible varnish containing lampblack is afterwards added.

The leather manufacture of Great Britain is of great importance, being inferior in point of value and extent only to those of cotton, wool, and iron.

The number of persons engaged in all the various branches of the manufacture in Great Britain is estimated at between 300,000 and 400,000, and the entire value of the manufacture at more than 20,000,000*l.* sterling, the leather for boots and shoes alone being valued at about 12,000,000*l.* Leather was long subject to a duty, which necessarily placed the manufacture under the surveillance of the excise; but the duty was totally abolished in 1830, and the manufacture is now relieved from every sort of trammel and restraint. (*Com. Dict.*)

Leaven (Fr. levain, from Lat. levare, *to raise*). A piece of sour dough used to ferment and render light a much greater quantity of dough or paste. By the Mosaic law leaven was forbidden during the Passover; hence St. Paul speaks of keeping the Paschal feast with the unleavened bread of sincerity and truth. Figuratively, the word is applied to anything which gradually but surely affects the moral or intellectual character of man, whether for good or for evil.

Lecanora (Gr. λεκάνη, *a basin*). A genus of Crustaceous Lichens. *L. tartarea* is the Cudbear of commerce; and some have supposed the manna of the Israelites to be *L. esculenta* and *affinis*, which in Armenia and Algeria are blown about and heaped by winds, and in times of scarcity ground up with corn.

Lecanoric Acid. A colourless crystalline body contained in the *Lecanora* lichen.

Lecca Gum. The gum of the olive-tree, collected abundantly at Lecca in Calabria.

Lecontite. A hydrated sulphate of soda and ammonia found in the cave of Las Piedras in Honduras, by Dr. le Conte, who considers it to be formed from the decomposed excrements of bats, large numbers of which have probably inhabited the cave for ages.

Lectern. A desk, or support for a book, for the use of readers in churches or other public places. The support is frequently made by the wings of an eagle, carved in wood or bronze. Many rich specimens of mediæval lecterns are found in churches in this country.

Lectica (Lat.). A sort of couch or litter,

used by the Romans, of two kinds, the one for carrying living persons, the other for bearing dead bodies to the funeral pile. The bearers were called *lecticarii.*

Lectisternium (Lat. from lectus, *a couch,* and sternere, *to spread*). A religious festival or ceremony among the ancient Romans, celebrated during times of public calamity, when the gods themselves were invited to the entertainment; their statues were taken from their pedestals, and laid on couches. The first festival of this sort, according to Livy (v. 13), was held in the year of Rome 354 (on the occasion of a contagious disease which committed frightful ravages among the cattle), and lasted for eight successive days. On the celebration of this festival, enemies were said to forget their animosity, and all prisoners were liberated.

Lector (Lat. *a reader*). In the early Church, a person set apart for the purpose of reading parts of the Bible and other writings of a religious character to the people. They were consecrated by prayers and ceremonies for this office, and in the third century appear to have been proper officers of the church. It is probably from this institution that the order of preachers in parish churches in England called *lecturers* is derived, who hold a distinct office from the vicar, rector, or other ecclesiastical functionaries; they are chosen by the vestry or chief inhabitants of the parish, supported by voluntary subscriptions and legacies, and usually officiate on Sunday afternoon. (Hook's *Church Dictionary,* art. 'Lecturer.')

Lecture. This word signifies generally a discourse *read* by a professor to his pupils; but it is applied in a more extended sense to every species of instruction communicated vivâ voce. In the Scotch and Continental universities, as well as in those recently established in England, the great business of teaching is carried on by means of public lectures, delivered at stated periods, and embracing every subject included in the curriculum of study; but at the two great English universities, the college tutors bear a principal part in the work of instruction. Still, within the last few years the professorial system has been made much more efficient, and has acquired more general importance.

Public lectures have been adopted from the earliest ages as a convenient mode of teaching the elements of every branch of human knowledge; and if they be properly compiled, and accompanied by strict and regular examinations, few means seem better calculated to awaken the attention of the student, to abridge his labours, and to guide his enquiries.

Lecythidaceæ (Lecythis, one of the genera). A natural order of epigynous Exogens belonging to the Myrtal alliance of Lindley, and known by their dotless leaves, polypetalous flowers, their indefinite stamens collected into a fleshy hood, and their many-celled ovary. They are large trees, with showy flowers, found in the hottest parts of South America, and comprise the Cannon-ball tree, *Couroupita guianensis*; the Sapucaja *Lecythis Zabucajo,* and the *Bertholletia excelsa,* which furnishes the Brazil-nuts of the shops.

Lecythis (Gr. λήκυθος, *an oil jar*). A genus of South American trees of large size, representing the order *Lecythidaceæ.* They furnish some of the nuts of commerce. Thus, under the name of Sapucaja nuts, the seeds of *L. Zabucajo* are commonly sold in our fruit shops, and they will probably take the place of the closely allied Brazil nuts, to which they are greatly superior in point of flavour and digestibility. They are rather more than two inches long and one wide, covered with a longitudinally furrowed corky shell, and grow in large hard woody fruits, shaped like urns, measuring about six inches in diameter, and having close-fitting lids at the top. Our supply comes from Pará, and is principally the produce of the Brazilian forests.

L. ollaria is another species producing large fruits, commonly known as Monkey Pots, but its seeds are not so palatable as those of the last, having a bitter flavour.

Ledererite. A variety of Gmelinite found at Cape Blomidon in Nova Scotia, and named after the Baron L. von Lederer.

Ledorite. A massive variety of Sphene, found at Grenville in Canada, and distinguished as a sub-species on account of its peculiar cleavages.

Ledger. [BOOK-KEEPING.]

Ledgers. In Architecture, the horizontal pieces of timber used in scaffolding; they lie parallel to the wall opposite to which they are erected.

Ledger-line. In Music, a line either above or below the staff, when that is not sufficient in extent to lay the notes upon. It is above the staff in ascending progressions, and in descending progressions below it.

Ledges. On Shipboard, intermediate supports for the decks. They run across from side to side between and parallel to the beams, but are much thinner.

Ledum (Gr. λῆδον). The plant called Labrador Tea is *Ledum palustre,* a low shrub of the Ericaceous order.

Lee, Leeward. Sea terms, denoting generally the side or quarter not directly exposed to the wind. The *lee side* of a ship is the opposite to that on which the wind blows when it crosses her course, and which is termed the *weather side. Leeward* is on the *lee side*; opposed to *windward,* or on the *weather side.* A *lee shore* is the shore on the *lee side* of the ship, or the shore on which the wind tends to blow her; and a ship is said to be under the *lee* of the shore when the wind blows from the shore, or when she is in some measure sheltered by the shore. The names Leeward and Windward, as applied to the West India Islands, were given to them from their situation in a voyage from the ports of Spain to Carthagena or Portobello. The islands which lie to leeward extend from Porto Rico to Demerara.

Lee-board. A flat width of planking, which being let down perpendicularly into the water on the lee side of flat-bottomed vessels,

serves as a temporary keel, and opposes the action of the wind to drive them to leeward.

In the American *centre-board* boats, than which no craft can sail nearer to the wind, there is a deep lee-board working in a water-tight groove in the centre of the boat.

Lee-gage. This term implies the having a position farther to leeward than some other given object.

Lee-way. In Navigation, the deviation of the course actually run by a ship from the course steered upon; or it is the angle formed between the line of the ship's keel and the line which she actually describes through the water. In consequence of the action of the wind or currents, a ship is generally impelled *sideways* as well as forward, whence the direction of her motion is different from that of the keel. Suppose the whole force urging the ship to be resolved into two—one producing the motion A B in the direction of the keel, and the other the motion A C in the same time at right angles to the former; then the ship will move in the direction of the diagonal A D, and the angle D A B is the *lee-way*. To obviate the effects of this lateral motion, the ship is laid on a course to the windward of the point to which she is bound.

All needless top-hamper, as a poop or raised forecastle, increases the tendency to lee-way.

Leech (Goth. leikeis, lekeis, perhaps akin to Gr. λείχω, Eng. *lick*). This name is given to those abranchiate red-blooded worms, or anellidans, which are provided with a sucker at both ends of the body [Hirudo], and of which we possess a few native species; some frequenting the fresh waters, as the horse leeches (*Hæmopis sanguisorba* and *H. stagnorum*); others inhabiting the ocean, where they are parasitic upon fishes, as the skate-sucker (*Pontobdella muricata*). The medicinal leech (*Sanguisuga medicinalis*) belongs to that subdivision of the family *Hirudinidæ* which is characterised by having the superior lip of the anterior cup or sucker divided into several segments, and the oral aperture transverse, triradiate, and surrounded by three cartilaginous jaws, each armed with two rows of very fine teeth. This apparatus enables the leech to penetrate the skin so as to insure a ready flow of blood without causing a dangerous wound. The upper lip is marked with ten small points considered as eyes. The species of the genus *Sanguisuga*, viz. *S. officinalis* and *S. medicinalis*, are most common in the south of France, whence great numbers are exported to this country. The leech-dealers of Bretagne drive horses and cows into the ponds, that the leeches may fatten and propagate more abundantly by sucking their blood. Children are employed to catch them by the hand; and grown persons wade into the shallow waters in the spring of the year, and catch the leeches that adhere to their naked legs. They are also taken by a sort of net made of twigs and rushes, which is used in the summer when the leeches retire into the deeper waters.

The best method of preserving these valuable little animals is stated by the author of the article 'Leech' in the *Penny Cyclopædia* to be that described by Fée. It is as follows:—

Into a marble or stone trough a layer of seven inches of a mixture of moss, turf, and charcoal is to be put, and some small pebbles placed above it; at one extremity of the trough, and midway between the bottom and the top, place a thin plate of marble pierced with numerous small holes, upon which there should rest a stratum of moss, or portions of the *Equisetum palustre*, or horse-tail, firmly compressed by a layer of pebbles. The trough is to be filled with water only so high that the moss and pebbles should be but slightly moistened. A cloth is to be kept over the mouth of the trough. This is imitating as nearly as possible their natural condition; and the charcoal not only aids in keeping the water sweet, but appears to prevent the leeches being attacked by parasitic animals, to which they are very liable. The water should be changed about once a week, and more frequently in warm weather.

The great importance of ascertaining the best method of preserving the medicinal leech may be inferred from the extent to which the trade is carried on, and the consequent increasing scarcity of these indispensable adjuncts to medicine. Four only of the principal dealers in London import 7,200,000 annually.

Leeches of a Sail. The side edges of a sail. *Leech-lines* are small ropes from the middle of the leeches of a sail to blocks on its yard on the opposite sides of the mast; when hauled, they brail up the sail and rapidly diminish its area.

Leedsite. A mechanical mixture of the sulphates of lime and baryta found in a carboniferous rock between Leeds and Harrogate in Yorkshire.

Leefange. An iron bar across a ship's deck for the sheet of a fore-and-aft sail to slip on during tacking.

Leek (A.-Sax. leac). The *Allium Porrum* of botanists. [Allium.]

Leelite. A silicate of alumina coloured of a deep flesh-red by a small percentage of manganese. It occurs compact and massive, with a peculiar wax-like texture, and a lustre and translucency like that of horn, at Gryphyttan in Sweden. It was named after Dr. J. F. Lee of Cambridge, and is the Helleflinta of the Swedes.

Leet (A.-Sax. leod; Ger. leute, *people*). The court leet, or view of frankpledge, was an ancient Anglo-Saxon institution answering a double purpose: 1. The administration of justice in the trial of offences and the abatement of nuisances; 2. The preservation of the peace, and the prevention of crime, by the reception and enrollment of the pledge which each man was obliged to give by becoming a member of some tything. The possession of a court leet was the characteristic of the hundred, of which the proper leet was distinct from, and subordinate to, that which was held by the sheriff

on his tourn. The court leet of the hundred was usually held by a bailiff or steward of the sheriff; but it was sometimes granted, as well as the leet of a smaller jurisdiction, to private lords. A court leet also properly belonged to a borough, which ranked as a hundred; but such private and borough leets were, like the leet of the hundred, subordinate to the county leet of the tourn.

Legacy (Lat. lego, *I bequeath*). A gift by will of personal property, as goods and chattels; a testamentary gift of real property being called *a devise*. Legacies are general, such as a gift of a sum of money out of the general estate of the deceased; or specific, as a gift of a particular bank note or coin, or of any other individual chattel, as a horse or a jewel; or residuary, as a gift of the residue of the estate remaining after all the debts of the deceased and general and specific legacies have been satisfied. General legacies are subject to an equal rateable abatement, if the estate is not sufficient for payment of them in full; but a specific legacy is not subject to abatement, unless it be necessary for the payment of debts. A specific legacy is, however, subject to what is called *ademption*, which is the consequence of the subject-matter of the legacy being one identical thing in specie: thus, if a testator bequeath a particular horse, which he afterwards disposes of in his lifetime, the legacy is said to be adeemed, or taken away, because the horse bequeathed has no longer any existence as part of his property, and the legatee will not be entitled to another horse of the testator's in lieu of it. This identity of corpus is so inherent in the notion of a specific legacy, that if 100*l.* in consols were bequeathed, and the same sum were afterwards transferred by the testator to another stock, the transfer of itself would adeem the legacy. The mode of compelling executors to pay a legacy is by suit in equity for the administration of the testator's assets: courts of common law have not, in general, any jurisdiction over such matters. Executors cannot be compelled to pay a legacy until the expiration of a year after the testator's death: they are allowed that period for ascertaining and discharging his debts; and even after a legacy has been paid, the legatee must refund if it should be necessary for the payment of creditors who come in, although after the period above mentioned. The party to whom a legacy is bequeathed is termed *legatee*. [WILLS.]

Legate (Lat. legatus). A high functionary, in general a cardinal or bishop, whom the pope sends as ambassador to the courts of foreign powers. Legates are—1. A Latere, who possess the highest degree of authority, these only being commissioned by the pope to take his place in councils; 2. De Latere; 3. Legates by office are such as enjoy the titular distinction of legate by virtue of their dignity and rank in the church, but have no special mission.

Legation. [AMBASSADOR; DIPLOMACY.]

Legato (Ital. *tied*). In Music, a term used to denote the tying one note to another, which is done by placing these marks ‿ ⁀ above or below the notes intended to be so joined. The legato mark placed over a series of notes indicates that they are to be played smoothly, as if the sounds were bound together. The word applied as a general direction for a piece intimates that it is to be performed in a smooth style.

Legatura. In Music. [DRIVING NOTES.]

Legatus (Lat.). In Roman History, legati were of two kinds: 1. Ambassadors, corresponding to those of modern times; 2. Legates, who accompanied the proconsuls and prætors into their provinces, or aided the general in the management of his army. Legates of this last-named class varied in number according to the requirements of the service in which they were engaged; and legates of the former class governed provinces in the absence of the proconsul or prætor, sometimes without any mention of the officer whose deputies they were.

Legend (Lat. legenda, *things to be read*). A book originally used at divine service. In it were recorded the lives of saints and martyrs, portions of which were selected and read for the edification of the people. These legends were studiously perused in the refectories of cloisters, and were earnestly recommended to the perusal of the laity, as so many evidences of the truth of the Roman Catholic faith. Among these the *Golden Legend* (the work of Jacobus de Voragine, archbishop of Genoa in the thirteenth century), which is a collection of the lives of the saints, maintained its ground in the church for two hundred years. But although many of the legends consist of tasteless and unmeaning fictions, many are of a highly poetical and striking character, and throw much light on the diffusion of myths. There are some sensible remarks as to the value of the early Christian legends in Beugnot, *Histoire de la Destruction du Paganisme en Occident*, i. 280. In a general sense, the term *legend* is used to denote any fictitious or doubtful narrative; such as the exploits of heroes of the middle ages, or the history of a people or district in which truth is so mixed with fable as to be inseparable from it. [MYTHOLOGY.]

LEGEND. In Numismatics, that which is written *round* the field of a medal; opposed to *inscription*, which is written across it. [NUMISMATICS.]

Legendre's Symbol. In the theory of numbers, a symbol employed in investigating the quadratic character of any positive or negative number A which is prime to a prime number p. It was first introduced by Legendre in his *Essai sur la Théorie des Nombres*, Paris 1798; is written thus $\left(\frac{A}{p}\right)$; and has the value 1 or -1 according as A is a quadratic residue or not. It may, therefore, be defined by the congruence

$$A^{\frac{p-1}{2}} \equiv \left(\frac{A}{p}\right) \pmod{p};$$

for if A be a quadratic residue, we have

$$x^2 \equiv A,$$

and hence, by FERMAT'S THEOREM,

$$x^{p-1} \equiv A^{\frac{p-1}{2}} \equiv 1 \left(\text{mod. } p\right).$$

It may easily be shown that if A, when resolved into its prime factors, has the value

$$= a_1^{a_1} a_2^{a} \quad . \; a_m^{a_m},$$

$$\left(\frac{A}{p}\right) = \left(\frac{a_1}{p}\right)^{a_1} \left(\frac{a_2}{p}\right)^{a_2} \cdots \left(\frac{a_m}{p}\right)^{a_m};$$

so that in investigating the quadratic character of A, it is only necessary to examine those of its prime factors which appear with odd exponents. It may further be shown that

$$\left(\frac{-1}{p}\right) = (-1)^{\frac{p-1}{2}},$$

that

$$\left(\frac{2}{p}\right) = (-1)^{\frac{p^2-1}{8}},$$

and that, if p and q are odd primes (not both negative)

$$\left(\frac{p}{q}\right)\left(\frac{q}{p}\right) = (-1)^{\frac{1}{4}(p-1)(q-1)}.$$

The last equation is the expression of one of the most important and beautiful laws in the science of arithmetic. It is known as *Legendre's law of reciprocity*, having been first enunciated by that geometer in the *Histoire de l'Académie des Sciences* for 1785.. Gauss appears to have arrived independently at the same law, and was incontestably the first to publish a rigorous demonstration of it. Gauss, indeed, has given us no less than six demonstrations of this law, all more or less subtle, and, without exception, most valuable contributions to science. It would, in fact, be difficult to estimate too highly the many advantages to mathematical science which have resulted from the numerous demonstrations which have been given of this simple law, pronounced by Gauss himself to be 'the gem of the higher arithmetic.' The following enunciation is given by Prof. Smith in his admirable 'Report on the Theory of Numbers' (*Proceedings of British Association*, 1859), which the reader desirous of further information will do well to consult. 'If p and q be two primes, the quadratic character of p in regard to q is the same as that of q with respect to p, unless p and q have each the form $4n+3$, when their quadratic characters are opposite.'

Jacobi, in 1837 (see also Crelle's *Journal*, vol. xxx.), communicated to the Academy of Berlin the following extension of Legendre's notation and law. The symbol $\left(\frac{A}{P}\right)$, where P is a product of the equal or unequal *uneven* primes p_1, p_2, p_3, &c., being defined by the equation

$$\left(\frac{A}{P}\right) = \left(\frac{A}{p_1}\right)\left(\frac{A}{p_2}\right)\left(\frac{A}{p_3}\right)\ldots\ldots,$$

and Q being any other uneven number prime to P,

$$\left(\frac{P}{Q}\right) = (-1)^{\frac{1}{4}(P-1)(Q-1)}\left(\frac{Q}{P}\right).$$

Legerdemain (Fr. *light of hand*). A term given to some deceptive or sleight-of-hand performances, which depend either entirely on dexterity and address, or derive but a small degree of aid from philosophical principles. [MAGIC.]

Leggiadro (Ital.). In Music, a direction to the performer that the music to which the word is appended is to be performed gaily or briskly.

Legion (Lat. legio). A division of the Roman army, comprising ten cohorts, thirty maniples, or sixty centuries; so that if there had always been one hundred men in each century, as its name imports, the legion would have consisted of six thousand men. But the number was, in fact, variable.

There were usually three hundred cavalry joined to each legion, which were divided into ten troops (turmæ), and each of these troops into three bodies of ten men (decuriæ). The defensive arms of the legionaries were an oblong shield, a helmet, hauberk, and greaves; their offensive weapons were a sword and two long javelins. The legion was drawn up in three lines; the soldiers in each of which were distinguished by the names Hastati, Principes, and Triarii. The Hastati, who formed the first line, were young men in the flower of life, and originally used long spears, which were, however, afterwards discarded. The Principes occupied the second line, and were also men in the prime of life. The Triarii were veteran soldiers, and formed the third line. In each legion there were six military tribunes, who commanded under the consul, each in his turn, usually for about a month. This was the early organisation of the legion, as it is known to us chiefly from the description of Livy, at the time of the great Latin war in the fifth century of the Republic. It was materially changed in later times, and the three original lines were discarded, probably about the time of the Punic war. But it always retained its distinctive character of a separate army, provided with its complement of cavalry and light infantry; and it has been remarked, as a striking proof of the military genius of the Romans, that after so many ages of additional experience, recent captains, and particularly, Napoleon, have found it advantageous to divide their armies into separate corps, each in a similar manner complete, with its own cavalry and artillery; and these, in the French armies, usually averaged from 4,000 to 6,000 men, or about the number of a Roman legion. The organisation of the legion is explained in most works on Roman antiquities, but has been nowhere so thoroughly treated as by M. L. Beau, in a long series of memoirs which appeared from time to time in the *Mém. de l'Acad. des Inscriptions et Belles Lettres*. (See particularly vols. xxxv. xxxvii. xxxix.; also Smith's

Dictionary of Greek and Roman Antiquities, s.v. 'Exercitus.')

Legion of Honour. An order instituted by Napoleon I., when first consul of France, for merit, both military and civil. The order consisted, under the Empire, of grand crosses, grand officers, commanders, officers, and legionaries. They were divided into sixteen cohorts, each of 407 members; but the total number was afterwards much increased. Pensions, from 250 to 5,000 francs per annum, were attached to these distinctions. After the restoration of Louis XVIII. the order underwent some modifications in its constitution, and its members were reduced to a smaller scale. But among the first acts of the present emperor was the reconstitution of this celebrated order on an extended basis. This was effected by the law of April 19, 1852. The legion now consists (beginning with the lowest grade) of knights, who may in four years become officers, of whom there are 4,000. After two years these may be promoted to commanders, of whom there are 1,000; grand officers, 500, after an interval of three years; grand crosses, 80, after five years. But in all cases a campaign (or rather a campaign year) counts for two years. The highest functionary is the grand chancellor.

Legislation. [LAW.]

Legislature. The name given to the body or bodies in a state in whom is vested the power of making laws. Thus the King, Lords, and Commons of Great Britain, whose united consent is indispensable to the framing of a law, are styled *the legislature.*

Legitimacy (Lat. legitimus, *lawful*). In Jurisprudence, the state of a child born in lawful wedlock.

LEGITIMACY. In Politics, this term signifies, in its strictest sense, the accordance of an action or of an institution with the municipal law of the land. The principle of obedience to civil authority, in whatever hands the law has placed it, is consecrated by religion as well as by sound philosophy. Resistance to, or evasion of, the legal commands of a superior, is thus an offence against the law of God as well as of man, in things in themselves indifferent as well as in things commanded by the principles of morality. How far they must be obeyed when against the conscience of the subject, is one of those questions of casuistry which never can receive a solution applicable to all cases and circumstances. In this sense it is clear that the attribute of legitimacy belongs to no particular form of government, but is equally inherent in all when lawfully established. But, looking at the subject from a higher point of view, the question arises, when and how shall a government be taken to be lawfully established? This can only be directly answered by two classes of political philosophers. The first attribute the quality of legitimacy only to hereditary monarchical government, which they conceive to be peculiarly of divine appointment, deriving it from the patriarchal form of society. This theory has the advantage of simplicity; but its advocates have never been able to show any real foundation for it. [DIVINE RIGHT; NON-RESISTANCE.] The second class bases society on the abstract rights of man, attributes all power to the people, and considers no government legitimate except such as is founded on their consent. This theory also is plain and clear in the abstract; but has the defect of becoming impossible in application. For, 1. The principle of the *social contract*, or implied consent of the people, is a mere philosophical fiction; 2. The actual consent of the people (i.e. the majority of it) to any existing form of government has never been satisfactorily ascertained. This was notoriously the case in every European country, until at least the singular experiments made of late years in France under the name of universal suffrage. And even the representative government of the United States of America is chosen by a constituency from which *slaves*, women, and persons under twenty-one years of age (that is, in all, five-sixths of the population) are excluded. Now the exclusion of any one of these classes can only be justified on grounds of expediency; and similar grounds might equally justify the adoption of other tests (e.g. that of property, as in England), which would still further reduce the number of the constituency; 3. Supposing a government established by the actual voices of a majority of the whole people, the question would still arise, whether every subsequent act of that government was legitimatised by that original validity. This question was much debated in France at the period of the trial of Louis XVI.; when the Convention, elected by a majority of the people, was assuming the extraordinary power of judging that monarch. The Girondins on that occasion contended that an appeal to the people (i.e. to the suffrages of a majority of the constituents) was necessary in order to ratify the act; and in a greater or less degree it must always arise, whenever an alteration in circumstances since the period of the election of the representative body has called for the adoption of extraordinary measures. Between these two classes of theoretical politicians, the greater number are content to hold that the only fundamental principle of government is expediency, and its only right that given by municipal law or peaceable possession. In their view all government is equally legitimate so soon as it is fairly established; while they fully admit that a question, and often a very difficult one, arises on every violent change of institutions, as to how soon the new government de facto has acquired the character of legitimacy. In the language of modern politics this word has acquired a peculiar sense, chiefly from its employment about the period of the congress of Vienna, when the old hereditary dynasties were termed legitimate in contradistinction to those which the French revolution and the subsequent wars had founded. Hence the principle of legitimacy has been, very incorrectly, opposed

to that of representative or popular government; a mere abuse of terms, but an important one, from the powerful effect which words are able to produce in political discussion.

Legitimation. The act by which natural children are rendered legitimate. By the jurisprudence of countries under the Roman or civil law, subsequent marriage of the parents legitimatises bastard issue.

Legumen (Lat.). In Botany, a one-celled, one or many seeded, two-valved, superior fruit, dehiscing by a suture along both its face and its back, and bearing its seeds on the ventral suture only. It differs from the follicle only in dehiscing by two valves. Sometimes it is indehiscent, as in *Cassia fistula*, &c.; but the line of dehiscence is in such species indicated by the presence of sutures.

Legumin. *Vegetable casein.* An albuminoid matter existing in leguminous plants. It is an important flesh-forming constituent of peas, beans, and other leguminous or *pod* vegetables.

Leguminosæ. A very extensive natural order of polypetalous Exogenous plants belonging to Lindley's Rosal alliance. They are found in all parts of the world, forming large trees and huge twiners in the tropics, and being herbaceous plants or small bushes, rarely trees, in colder countries. The order contains a great variety of useful and beautiful species, some of which, like Clover, Lucern, Saintfoin, and Vetches, are cultivated for cattle; others, as Peas, Beans, Lentils, and various other kinds of pulse, form part of the food of man. Indigo, Logwood, and many others are well-known dyeing plants. Several *Acacias* produce gum arabic. Certain *Astragali* yield tragacanth. The Tamarind and others bear pods whose interior is filled with an agreeable fæcula or pulp; *Cassia acutifolia* and others yield Senna; *Glycyrrhiza* the Liquorice root; *Ceratonia* is the wild Locust Fruit of Scripture. Finally, many are valuable tonics, and some are poisonous, among which is the common LABURNUM [which see]. The larger part of this order consists of plants called Papilionaceous, from a fancied resemblance between their flowers and a butterfly. Such plants have one large expanded petal, and four others much smaller, which form alæ and carina in front of the vexillum; but in others the more usual form of corolla is observed, and there are even some which, like *Ceratonia*, are apetalous. The division of the order called *Mimosæ* is remarkable for having very small flowers with long stamens, and growing in balls or spikes.

Lehrbachite. A native selenide of mercury and lead (probably a mechanical mixture of the two selenides), occurring at Lehrbach in the Harz.

Lehuntite. A compact variety of Natrolite, found at Glenarm in Antrim, by Captain Lehunt, after whom it was named.

Leibnitz's Theorem. In the Differential Calculus, a theorem concerning the successive differentiation of a product of two functions. It is most easily remembered in its symbolical form. If by D_u we denote the operation $\frac{d}{dx}$ applied exclusively to u, and by D_v the same operation applied exclusively to v, we have, obviously,

$$\frac{d(uv)}{dx}=v\frac{du}{dx}+u\frac{dv}{dx}=(D_u+D_v)\,uv,$$

and generally,

$$\frac{d^n(uv)}{dx^n}=(D_u+D_v)^n uv=v\frac{d^n u}{dx^n}+n\frac{d^{n-1}u}{dx^{n-1}}\frac{dv}{dx}$$
$$+\frac{n(n-1)}{1.2}\frac{d^{n-2}u}{dx^{n-2}}\frac{d^2v}{dx^2}+\&c.\ .\ .\quad+u\frac{d^n v}{dx^n},$$

which is the theorem in question.

Lemanite. A synonym of Saussurite, after Lake Leman, in the neighbourhood of which it is found.

Lemma (Gr. λῆμμα, *anything taken*). In Geometry, a preliminary proposition, laid down for the purpose of facilitating or rendering more perspicuous the demonstration of a theorem or the construction of a problem.

Lemming. A name given to a species of claviculate Rodents (*Hypudæus Lemmus*, Ill.) very abundant in the north of Europe on the shores of the Arctic Ocean. It is as large as a rat, and is remarkable for its occasional migrations in innumerable bodies. At these periods the lemmings are said to march in a straight line, regardless of rivers and mountains; and, unimpeded by any obstacle, they devastate the country over which they pass. [MIGRATION.]

Lemna (Gr.). The Duckweed genus, a curious family of plants, consisting of small, usually round shield-like bodies floating on water, and forming the 'green mantle of the standing pool.' They belong to the *Pistiaceæ*, are of very singular structure, and well worth examination.

Lemnian Earth. A clayey substance found in the island of Stalimene (Lemnos), and used as a medicine in Turkey. It was formerly dug up once a year with much solemnity, and stamped with an official seal. [TERRA SIGILLATA.]

Lemniscata of Bernoulli. A curve of the fourth order having the form of the figure 8. Its polar equation is

$$r^2=a^2\cos 2\theta,$$

a particular case, therefore, of the more general equation

$$r=a\cos^e\frac{\theta}{e},$$

which represents a family of curves of which each individual has for its inverse, its reciprocal, and its pedals a curve of the same family. [PEDAL.] The constant e in these curves indicates the constant ratio of the segments into which any radius vector is divided by projecting upon it, orthogonally, the corresponding centre of curvature. The equations of the inverse, the reciprocal, and the n^{th} pedal of

$$r=a\cos^e\frac{\theta}{e}$$

are obtained, respectively, by changing ϵ into $-\epsilon$, $-(1+\epsilon)$, and $n+\epsilon$. In the case of the lemniscata $\epsilon = \frac{1}{2}$, its first negative pedal, therefore, has the equation

$$r = a \cos^{-\frac{1}{2}} 2\theta$$

or

$$r^2 \cos 2\theta = a^2,$$

which is well known to be that of an equilateral hyperbola; so that the *lemniscata is the first positive central pedal of the equilateral hyperbola.* The properties of the above family of curves have been investigated by W. Roberts (Liouville's *Journal*, vols. x. xii. xv.), by Prof. Hirst (*Annali di Matematici*, 1859), and by several others. The entire arc S of any such curve being known, as well as that of its pedal S_1, those of all other pedals can be found by means of the simple and remarkable relation

$$\frac{S_n}{S_{n+2}} = \frac{\epsilon_{n+1}}{\epsilon_{n+2}},$$

from which latter can be deduced the equally interesting relation

$$\frac{S_n \, S_{n+1}}{\epsilon_{n+1}} = 2\pi a^2,$$

which holds for all values of n for which $\epsilon_n = n + \epsilon$ is positive.

The arcs of the lemniscata can be added, multiplied, or divided algebraically. On this subject the reader may be referred, however, to Legendre's *Exercices de Calcul Intégral*, t. i., and to a memoir by Serret in Liouville's *Journal*, t. x.

The integral

$$s = \int_0^r \frac{dr}{\sqrt{1-r^4}},$$

which expresses the length of a lemniscate arc, is called a *lemniscate integral*; its inverse r considered as a function of s is called a *lemniscate function.* These functions play an important part in the theory of numbers; they bear the same relation to the theory of complex numbers as that which circular functions have to that of ordinary real numbers.

Lemon (Ind. leemoo). The fruit of the *Citrus Limonum.* [CITRUS.]

Lemons, Essential Oil of. A liquid contained in the cells of lemon peel. It may be collected by pressing a quantity of the peel. Its chief constituent is a fragrant hydrocarbon isomeric with oil of turpentine. When used by confectioners, it forms a disagreeable substitute for the fresh peel.

Lemons, Essential Salt of. The binoxalate of potash is often sold under this name; it is chiefly used for removing iron-moulds and ink-stains from linen.

Lemur (Lat. lemur, *a ghost*). This term was applied in the Linnæan system to several of the lower Quadrumanous animals of different structure and habits; it is now restricted to those which have the inferior incisors long, compressed, straight, and sloping forwards, and the lower canines approximated, and of similar form and direction, differing only in a slight increase of size, whence they have usually been enumerated as incisors: the upper incisors are straight, and the intermediate ones are separated from each other. The long pointed canines of the upper jaw are principally opposed to the trenchant anterior false molars below. Each of the four extremities is provided with an opposable thumb; but the index digit of the hinder hand has its nail developed into a long, curved, sharp-pointed claw. The use of this claw is to clean or dislodge vermin from the long and thick woolly hair. The lemurs deviate from the typical Quadrumanes, and approximate to the ordinary quadruped in their elongated pointed head and sharp projecting muzzle; the posterior limbs are a little longer than the anterior; the tail is long, thick, and bushy. They are all natives of Madagascar and of some of the smaller islands in its neighbourhood. To judge from the nature of their covering, it might be supposed that the lemurs were natives of a cold climate; but their fur has relation to the season of their activity. They sleep by day, and move about in the night season, during which time the air is often sufficiently cold in the tropical latitudes. Their nutriment is a mixed diet of fruits, insects, and small birds; the latter they surprise while at roost.

Lemures (Lat.). In Mythology, spirits of the dead which in the belief of the Romans were able to hurt the living. Hence it was necessary to propitiate them; and this was done specially at the Lemuria, which recurred yearly in the month of May.

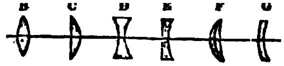
Lemuridæ. The family of Quadrumanous Mammals of which the genus *Lemur* is the type. [STREPSIRHINA.]

Lengthening Pieces. In Shipbuilding, the portions of each rib, above the top timbers, which are laid on to impart the necessary height to the sides of the vessel.

Lenitive Electuary. The ingredients of this preparation are senna leaves, the pulp of figs, tamarind, cassia, and prunes, coriander seed, liquorice root, and refined sugar. When properly made it is an elegant preparation, but (says Dr. Paris) the directions of the *Pharmacopœia* are rarely followed; the great bulk of it sold in London is little else than prunes, figs, and 'jalap.' (*Pharmacologia.*)

Lens. In Optics, a thin piece of glass or any other transparent substance, bounded on both sides by polished spherical surfaces, or on the one side by a spherical and on the other by a plane surface; and having this property, that parallel rays of light in passing through it have their direction changed, so as to converge to a given point called the *principal focus* of the lens, or to diverge as if they proceeded from that point.

Lenses receive different denominations according to their different forms. Thus,



A *spherical lens*, shown at A, is a sphere or globule of glass.

A *double convex lens*, shown at B, is a solid formed by two convex spherical surfaces; and is *equally convex* or *unequally convex*, according as the radii of its two surfaces are equal or unequal.

A *plano-convex lens*, C, is that of which one of the surfaces is *plane*, and the other *convex*.

A *double concave lens*, D, is bounded by two *concave* spherical surfaces, which may have either the same or a different curvature.

A *plano-concave lens*, E, has one surface *plane* and the other *concave*.

A *meniscus*, F (so called from its resemblance to a little moon, Gr. *μηνίσκος*), is a lens of which one of the surfaces is *convex* and the other *concave*, and which meet if continued. The radius of the convex surface is consequently smaller than the radius of the concave.

A *concavo-convex lens*, G, is that of which one of the surfaces is *concave* and the other *convex*; but in this case the surfaces will not meet though continued, the radius of the concave surface being smaller than that of the convex one.

The straight line M N which passes through the centres of all the curved surfaces, or is perpendicular to both surfaces of the same lens, is called the *axis* of the lens; and it is in this line that the focus of the lens is situated.

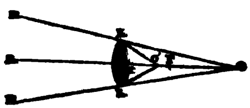
It was observed, at an early period, that a transparent body of a spherical form had the property of collecting at the focus the parallel rays of light which fall on its surface. But it was remarked, at the same time, that the illumination at these foci was extremely feeble, in consequence of the thickness of the glass through which the light had to pass. This inconvenience is removed by taking only two small segments instead of the entire sphere; by which means, as the refraction takes place only at the surfaces, and not in the interior of the glass, the very same refraction of the rays is produced as when the whole sphere is used; and the thickness of the glass being greatly diminished, the rays pass through it in much greater number, and the intensity of the light in the focus is much more considerable.

The rules for finding the focal distances of the different sorts of lenses are the following. They depend in some measure on the refracting power of the glass. We shall here suppose the index of refraction to be 1·500.

1. Rays of light, R L, R L, falling on a convex lens in directions parallel to the axis, are refracted to the point F, which is called the principal

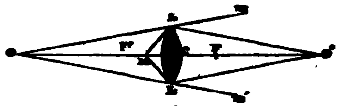
focus. In a *double* and *equally* convex lens the distance of F from C, the centre of the lens, is equal to the radius of the spherical surface. If the lens is *plano-convex*, the focal distance is equal to twice the radius of the spherical surface. If the lens is unequally convex, its focal distance is found by this rule: Multiply the two radii of its surfaces, and divide twice that product by the sum of the radii; the quotient will be the focal distance required.

2. When the rays falling on a convex lens, whose principal focus is F, converge towards a point O, their convergency will be hastened, and



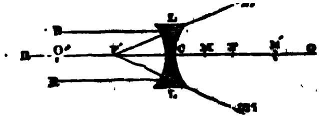
they will be refracted to a [illegible] O′, which is nearer the lens than the [illegible] focus F. The two points O and O′ are [illegible] *conjugate foci*; and they are related [illegible] other in such a manner that C O′ is a fourth proportional to C O+C F, C O and C F. Hence, when the point O is given, the conjugate focus O′ will be found by this rule: Multiply the principal focal distance C F by C O, and divide the product by the sum of those numbers. It is obvious that as the distance of O becomes greater, O′ approaches to F, and when O is at an infinite distance O′ coincides with F.

3. Suppose diverging rays issuing from a point O to fall on a double convex lens of which the principal focus is F. In this case they will be refracted to a point O′; and the conjugate foci O and O′ are so related that C O′ is a fourth



proportional to C O—C F, C O and C F. Hence O′ is found by the following rule: Multiply the principal focal distance C F by C O, and divide the product by the difference between C O and C F. As the point of divergence O recedes from the lens, the point O′ approaches nearer to F; and when O is at an infinite distance O′ coincides with F. As O approaches the lens, O′ recedes from it; when O is at F′ (the focal distance) the refracted rays become parallel to the axis; and when O is between F′ and C, as at M, the refracted rays diverge in the directions L *m* L *m′*.

4. The focal distance of a concave lens is the same as that of a convex one whose surfaces have the same curvature, and the rules for finding the conjugate foci are precisely the same; but the rays, instead of being collected, are scattered by passing through a concave lens, and the principal focus is on the same side as the point from which the rays proceed. Parallel rays R L, R C, R L, falling on the concave lens L L in the direction of the axis, become divergent, as if they proceeded from F′ (the principal focus). When the rays which fall on



a concave lens converge towards the point F, they are refracted in the direction parallel to

the axis. When the incident rays converge to a point O beyond F, the refracted rays diverge as if they proceeded from a conjugate point O′ also farther from the lens than F′; and when the incident rays converge towards a point M, between C and F, the refracted rays will be convergent, and meet in a conjugate point M′ on the same side of the lens with M. These conjugate foci are determined by the rules which have been given for convex lenses. Lastly, when the incident rays diverge from a point O′, farther from the lens than the principal focus, the refracted rays will be more divergent, and proceed as if they emanated from a point between the principal focus and the lens. The rule is, in this case, also the same as for convex lenses.

5. The effect of a meniscus is the same as that of a convex lens of the same focal distance; and that of a concavo-convex lens the same as that of a concave lens of the same focal distance. The principal focal distance is found by this rule: Divide twice the product of the two radii by the difference of the radii.

In deducing the above rules it has been assumed that the focus into which the rays are refracted is a mathematical point; but this is not strictly true, unless the rays only fall on the lens very near its centre, by reason of the *spherical aberration*. [ABERRATION.] For the correction of the *chromatic aberration*, arising from the unequal refrangibility of the luminous rays, see ACHROMATISM. [LIGHT; OPTICS; REFRACTION.]

Lens-shaped, Lenticular, or Lentiform. In Botany, a term used in describing the general figure of bodies, to denote their resembling a double convex lens.

Lent. A solemn time of fasting in the Christian church; so called from the A.-Sax. lencten, Ger. lenz, *spring*. The term of Lent comprises the period of six weeks and four days from Ash-Wednesday to Easter; but the six intervening Sundays being omitted, it is reduced to exactly forty days; the time assigned for the fast which preceded the temptation of Christ in the wilderness. [EASTER.]

Lente or **Lento** (Ital.). In Music, a direction to the performer that the music to which the word is prefixed is to be performed slowly. [ALLEGRO.]

Lentibulariaceæ. A very small natural order of herbaceous Exogens, natives of the marshes and waters of all parts of the world. They are nearly allied to *Scrophulariaceæ*, but are distinguished from them by their free central placenta and minute exalbuminous embryo; and from *Primulaceæ* by their irregular flowers, their stamens, and their ovary. The beautiful *Pinguicula*, a wild plant in marshes, is one of the genera, and *Utricularia* another. They are of no known use.

Lenticels or **Lenticular Glands.** In Botany, a term invented by De Candolle to denote certain minute speck-like tubercles on stems. Notwithstanding the importance assigned them by this great botanist, his lenticels appear to be nothing more than the points of roots attempting to spring from the surface of bark.

Lentigo (Lat.). A freckle of the skin: so named from its resemblance to a lentil seed.

Lentil (Fr. lentille, Lat. lens, lentis). The seed of a small Leguminous plant, the *Ervum Lens* of botanists. [ERVUM.] The *Revalenta* and *Ervalenta* of the shops are prepared from these seeds.

Lenzinite. A hydrous silicate of alumina, allied to Halloysite. There are two kinds, found at St. Gall in the Eifel (the opaline and the argillaceous), both of which are white, and translucent, and fall into small hard grains when put into water. Named after Lenz, a German mineralogist.

Leo (Lat. *a lion*). One of the zodiacal constellations, situated chiefly on the northern side of the ecliptic. The star *Regulus*, called also *Cor Leonis*, belongs to this constellation.

Leo Minor. The Little Lion: a constellation of the northern hemisphere, between Leo and Ursa Major. This constellation has been formed by the moderns, and is not given in Ptolemy's catalogue.

Leonhardite. A hydrated silicate of lime and alumina found at Schemnitz in Hungary, and Copper Falls, Lake Superior. It is named after Professor von Leonhard.

Leonine Verses. Latin verses according to the rules of ancient prosody, but rhymed. The name is said to be derived from one of the popes Leo, or, more probably, from a monk called Leoninus. The end rhymes to the middle, i.e. to the two last syllables before the cæsura, in hexameters; in pentameters, the two divisions are rhymed. The following distich may serve as an example:—

Dæmon languebat, monachus tunc esse volebat;
Ast ubi convaluit, mansit ut ante fuit.

Leopard Wood. The timber of *Brosimum Aubletii*, a South American tree of the order *Artocarpaceæ*.

Leopard's Bane. The common name of the genus *Doronicum*, but more especially applied to *D. Pardalianches*.

Lepadites (Gr. λεπάς, *a limpet*). Goose barnacles; an order of Cirripeds, comprehending those which have a long flexible contractile stem, fixed by its base to some solid body, and supporting at its extremity the principal parts of the animal, enclosed by a multivalve shell or coriaceous case.

Lepadogaster (Gr. λεπάς, and γαστήρ, *stomach*). A genus of Discobolous Malacopterygian fishes, having the following characters: pectoral fins expanded, with stouter rays at their lower edges, which curve slightly forwards, and unite with each other beneath the throat by means of a transverse membrane directed forwards, constituting the boundary of an adhesive disc, close to which there is a second, formed by the union of the ventrals; body smooth, and without scales; head broad and depressed; snout salient and protractile;

branchiæ slightly cleft, and furnished with four or five rays; dorsal fin single, and opposite to the anal, which is near the tail. Of this genus we possess two native species; one of which, called the Cornish sucker (*Lepadogaster cornubiensis*), was discovered by Dr. Borlase on the coast of Cornwall; the other (*Lepadogaster bimaculatus*) has been taken on different parts of the South Weymouth coast. Both species adhere by means of their ventral suckers to rocks, stones, &c., whence the generic name; they feed principally on Crustacea.

Lepals. In Botany, a term invented to denote stamens that are sterile; it is very rarely used.

Lepidine. The name of an oily basic compound ($= C_{10}H_9N$) obtained by distilling quinia or cinchonia with a solution of potash.

Lepidium (Gr. λεπίδιον, *a small scale*). A genus of *Cruciferæ* comprising amongst its species *L. sativum*, the Garden Cress, which is extensively grown and mixed with young mustard to form what is called *small-salading*.

Lepidoids (Gr. λεπιδοειδής, *scaly*). A family of extinct fossil fishes belonging to the oolitic formation, remarkable for their large rhomboidal bony scales. Figures of these scales are given in Dr. Buckland's *Bridgewater Treatise*.

Lepidokrokite (Gr. λεπίς, *a scale*, and κρόκος, *saffron*). A variety of Brown Iron-ore, occurring at Spring Mills, in Pennsylvania.

Lepidolite (Gr. λεπίς, and λίθος, *a stone*). Lithia-mica. A mineral of a granular and foliated texture, of a peach-blossom colour. It is a silicate of lithia, alumina, and iron, together with fluoride of potassium. The Lepidolite from Moravia and North America contains the newly discovered metals Cæsium and Rubidium.

Lepidomelane (Gr. λεπίς, and μέλας, *black*). A variety of Mica occurring in the granite of Three Rock Mountains in Dublin county, and in Sweden.

Lepidoptera (Gr. λεπίς, and πτερόν, *a feather*). The third order of insects in the system of Linnæus, and the tenth in that of Latreille, who has given the following concise and comprehensive description of the characters common to the insects of this most interesting, useful, and beautiful group.

The wings are four, covered on both sides with minute generally coloured scales, resembling farinaceous dust, which are removed by merely coming in contact with the finger. The oral apparatus consists principally of a proboscis, to which the name *antlia* has been given, and which is rolled spirally between two palpi, covered with scales or hairs. This forms the most important part of the mouth, and is the instrument with which these insects extract the nectar from flowers, their only aliment. It is composed of two tubular threads, representing the maxillæ, each bearing near its external base a very small superior palp, in the form of a tubercle. The apparent (inferior) palpi, which form a sort of sheath to the proboscis, replace the labial palpi of the mandibulated insects: they are cylindrical or conical, usually turned up, composed of three joints, and inserted in a fixed labium, which compl es that portion of the buccal cavity inferior to the proboscis. Two little and scarcely distinct, corneous, and more or less ciliated pieces, situated, one on each side, on the anterior and superior margin of the front of the head, near the eyes, seem to be vestiges of mandibles. Finally, we observe, and under an equally small proportion, the labrum or upper lip.

The antennæ vary, and are always multi-articulated. Two ocelli are observable in several species, but concealed between the scales. The three segments of which the thorax is usually composed are united in one single body; the first is very short, and the two others are blended together. The scutellum is triangular, but the apex is directed towards the head. The wings are simply veined, and vary in size, figure, and position; in several the inferior ones are plaited longitudinally near the inner margin. At the base of each of the superior wings is a kind of epaulette, prolonged posteriorly, which corresponds to the piece called *tegula* in the Hymenoptera. The abdomen, composed of from six to seven annuli, is attached to the thorax by a very small portion of its diameter, and presents neither sting nor ovipositor. In several females, however, as in *Cossus*, the last rings become narrowed and extended, to form an oviduct resembling a pointed and retractile tail. The tarsi always have five joints. There are never more than two kinds of individuals, males and females.

The females usually deposit their ova, frequently very numerous, on the vegetable surfaces which are to nourish their larvæ, and soon after perish. [BUTTERFLY.]

The larvæ of Lepidopterous insects are well known by the name of *caterpillars*. They have six squamous or hooked feet, which correspond to the legs of the perfect insect, and from four to ten additional membranous ones, or *propedes*; the two last of which are situated at the posterior extremity of the body. Those caterpillars which have but ten or twelve in all have been called, from their mode of progression, *geometræ*. Several of these geometers, when at rest, remain fixed to the branches of plants by the hind feet alone, whence in the form, colour, and directions of their body, they resemble a twig. They can support themselves in this position for a long time without exhibiting the slightest symptom of life. So fatiguing an attitude must require prodigious muscular force; and, in fact, Lyonnet counted 4,041 *muscles* in the caterpillar of the *Cossus ligniperda*, or willow-caterpillar.

The body of these larvæ is generally elongated, almost cylindrical, soft, variously coloured; sometimes naked, and sometimes covered with hairs, tubercles, and spines. It is composed of twelve segments or annuli, exclusive of the head, with nine stigmata on each side. Their head is invested with a corneous

or squamous dermis, and presents on each side six shining granules, which appear to be ocelli; and it furnished with two very short and conical antennæ, and a mouth composed of strong mandibles, two maxillæ, a labrum, and four small palpi. The silk which they spin is elaborated in two long and tortuous internal vessels, of which the attenuated superior extremities terminate in the lip. A tubular and conical mamilla forms the spinneret through which the threads are spun.

Most caterpillars feed on the leaves of plants; some gnaw their flowers, roots, buds, and seeds; others attack the ligneous or hardest part of trees, softening it by means of a fluid which they disgorge. Certain species attack our woollens and furs, thereby doing us much injury; even our leather, bacon, wax, and lard, are not spared by them. Several confine themselves exclusively to a single article of diet; others are less delicate, and devour all sorts of organised matters.

Some of them form societies, and frequently live under a silken tent, spun by them in common, which even shelters them in winter. Several construct sheaths for themselves, either fixed or portable; others make their abode in the parenchyma of leaves, where they form galleries. The greater number are diurnal; the others never issue forth but at night. The severity of winter, so fatal to almost all insects, does not affect certain *Phalænæ*, which only appear in that season.

Caterpillars usually change their skin four times previously to passing into the state of a nymph or chrysalis. Most of them spin a cocoon in which they enclose themselves. A frequently reddish liquor, which Lepidopterous insects eject at the moment of their metamorphosis, softens or weakens the extremity of the cocoon, and facilitates their exit; one of these extremities, also, is generally thinner than the other, or presents a favourable issue by the peculiar disposition of the fibres. Other caterpillars are contented with connecting leaves, particles of earth, or of the substances on which they have lived, and thus forming a rude cocoon. The nymphs of the diurnal Lepidoptera reflect a metallic lustre, and are ornamented with golden spots, whence the term *chrysalis* applied to them; they are naked, and fixed by the posterior extremity of the body. The nymphs of all the Lepidoptera are swathed or resemble mummies. Those of several insects of this order, particularly of the *Diurna*, undergo their metamorphosis in a few days; they even frequently produce two generations in the course of the year. The caterpillars or chrysalides of others, however, remain during the winter in one of these states, and undergo their final transformation in the ensuing spring. The Lepidoptera issue from their nymphal envelope through a slit, which is effected in the back of the thorax.

Lepidopus (Gr. λεπίς, and πούς, *a foot*). A genus of Tænioid fishes, characterised by the reduction of the ventral fins to the condition of small scaly plates. The thin and elongated body is without scales: it is furnished with a dorsal fin, which extends its whole length, and a narrow anal fin; it terminates in a well-formed caudal. The branchiostegal rays are eight in number; the head is pointed, with a single row of laniary teeth in each jaw, the largest above, and others, very small, on the palatine and pharyngeal bones. Of this genus one native species is known, called the Scabbard-fish (*Lepidopus argyreus*). It is very rare: only four examples are recorded by Mr. Yarrell, which were taken on the southern shores.

Lepidosteus (λεπίς, and ὀστέον, *bone*). The bony pike of the fresh waters of North America. It is analogous to the Ganoid scaled fishes which existed in great numbers during the Palæozoic period. Its scales are hard, bony, rhombic, and arranged in oblique rows, descending backwards from the dorsal towards the ventral side.

Lepidote. In Botany, scurfy, or covered with membranous scales.

Lepidotus (Gr. λεπίς). In Palæontology, the name of a fossil fish, distinguished by its large thick rhomboidal enamelled scales, and its hemispherical or obtusely conical teeth: its remains are widely diffused through the Wealden formation.

Lepis (Gr. *a scale*). In Botany, a scale or scurf, consisting of a thin transparent membrane attached by its middle, and having a lacerated irregular margin, owing to the imperfect union, towards its circumference, of the cellular tissue of which it is composed. Hence the adjective *lepidote*.

Lepisma (Gr. *a scale* or *husk*). A Linnæan genus of Apterous insects, forming the first family of Thysanurous insects in the system of Latreille. The body of these apterans is elongated, and covered with small scales, frequently silvery and brilliant; from which circumstance the most common species has been compared to a little fish. The antennæ are setaceous, and usually very long. The feet are short, and frequently have very large and strongly compressed coxæ, resembling scales. These insects run with great velocity: some of them, by means of their caudal appendage, are enabled to leap. Several species conceal themselves in the cracks of the framework of windows, in wardrobes, under damp boards, &c.; others hide beneath stones.

Lepisma. In Botany, a term sometimes applied to the cup-shaped disc of *Pæonia* and *Aconitum*; but seldom employed.

Lepismidæ. The family of Thysanurous insects of which the genus *Lepisma* is the type. It includes the genera *Lepisma* proper and *Machiles*.

Lepolite (Gr. λεπίς, *a scale*, and λίθος, *stone*). A variety of Anorthite from Sweden.

Leporidæ. The hare tribe, or the family of Rodents of which the genus *Lepus* is the type.

Leprosy (Gr. λέπρα). This disease, if we are to understand the term as expressing the

leprosy of Scripture and of the old writers, of elephantiasis.

[illegible] (*Elephantiasis*

græcorum), and in all probability is hereditary, but not contagious. It begins generally in the tubercular form, the parts affected often becoming void of sensation. The features become distorted by deep thickening of the cellular tissue; while the skin gets corrugated, thickened, and deeply furrowed. Internal and deeper parts next become affected, and even the bones partake in the disease. These changes sometimes proceed rather rapidly, but in most cases many years of life are allowed, the disease making but very slow progress, or even for a time remaining stationary. The cause of the leprosy is at present unknown; some attributing it to the ingestion of diseased or putrid fish, while others speak of bad ventilation and dirt as having much to do with its causation. The disease still exists in the East and West Indies, in the Levant, and in Sweden and Norway, but it rarely occurs in England except in a very mitigated form. Nothing is known to cure this horrible malady, or even to afford relief by stopping its progress.

Leptospermum (Gr. λεπτόσπερμος, *with thin seed*). A genus of *Myrtaceæ* which yields the Tea-tree of Tasmania and Australia. The species is *L. lanigerum*.

Leptura (Gr. λεπτός, *slender*; οὐρά, *a tail*). A Linnæan genus of Longicorn beetles, now the type of an extensive family (*Lepturidæ*), in which the eyes are rounded and entire, or, if slightly emarginate, with the antennæ inserted before the emargination. The head is always inclined posteriorly behind the eyes, or is abruptly contracted at its junction with the thorax, in the manner of a neck: the thorax is conical or trapezoidal, narrowed anteriorly; the elytra become gradually narrower. The term *Leptura* is now restricted to those Lepturidans in which the head is abruptly narrowed immediately behind the eyes; the antennæ inserted near the anterior extremity of the internal emargination of the eyes, the two eminences from which they rise being almost confounded in one plane. The thorax is almost always smooth, or without lateral tubercles.

Lepurandra. A genus of *Artocarpaceæ* now frequently referred to *Antiaris*. [ANTIARIS.] *L. saccidora* is the Sack-tree of the West Indies. The tough fibrous bark is ingeniously constructed into sacks in the following manner. A tree of proper diameter is chosen, and cut into junks of the length which is required for the sacks; these junks are soaked for a short time, and then beaten with clubs, until the outer bark is removed and the inner loosened, when it is turned inside out, and either sewn up at bottom or a piece of wood left attached.

Lepus (Lat. *a hare*). A genus of Rodents peculiarly distinguished by having their superior incisors double; i.e. each of them has a smaller one behind it. The molar teeth are also more numerous than in most other Rodentia, there being six on each side of the upper jaw, and five on each side of the lower jaw: the ears are very long, the tail short and turned up. The species of this genus are called *hares* and *rabbits*. The eyes are large and prominent, and, with the well-developed ears, serve to announce to these timid and defenceless animals remote objects and sounds of peril: the strength and proportions of the limbs, of which the hind pair is much longer than the fore, enable them to escape by rapid flight. The smaller species, as the rabbit, add to their means of safety by burrowing in the soil. Among the anatomical characters of the genus *Lepus* may be reckoned the rudimental condition of the clavicles, and the reticulate bony structure of the infra-orbital spaces.

LEPUS. The Hare. In Astronomy, one of the forty-eight ancient constellations of Ptolemy, situated in the southern hemisphere.

Lernæa (Lat. Lernæus, an epithet for a snake, from the dragon of Lerna). A Linnæan genus of low-organised crustaceous animals, all of which are external parasites of fishes, and constitute the class *Epizoa* of modern systems.

Lernæiformes. The name of a family of Siphonostomous Crustaceans, comprehending those with a long vermiform body.

Lessons (Fr. leçon, Lat. lectio). Certain portions of the Scriptures read in most Christian churches during divine service. The performance of this duty in the ancient church devolved on the catechumen. In the English church, the greater part of the Old Testament is read once through in daily lessons; and the New Testament, with the exception of Revelations, thrice in the year.

In the Presbyterian church the word *lesson*, in this sense, is unknown; the selection of the passage to be read being left to the choice of the officiating clergyman.

Lestris (Gr. λῃστρίς, *a plunderer*, strictly applied to a pirate ship). A subgenus of Gulls, separated from the *Larus* proper on account of their large membranous nostrils opening nearer the point and edge of the beak, and their tail being pointed. They pursue the small gulls with singular pertinacity and boldness to rob them of their food; hence their name.

Lethargy (Gr. ληθαργία). A heavy unnatural slumber, sometimes bordering upon apoplexy, from which persons are not easily roused. It sometimes arises from a plethoric state of habit, in which case it requires depletion, but it often also is a symptom of over-fatigue of mind, and then nervine stimulants are indicated.

Lethe (Gr.). In Greek Mythology, the River of Oblivion: one of the streams of the infernal regions. Its waters possessed the quality of causing those who drank them to forget the whole of their former existence. (Virgil's *Æneid* vi.) The word recurs in the names Leto, Latona, Lethum, &c. [APOLLO.]

Letter (Fr. lettre, Lat. litera). A character used to express one of the simple sounds of the voice. Letters properly combined form the visible signs of those sounds by which we

communicate our ideas. For some remarks on the origin of letters, see ALPHABET.

Letters are distinguished by grammarians into vowels and consonants (which latter are again subdivided into mutes and liquids) and diphthongs, according to the organ employed in their pronunciation.

Letter. In Printing, the usual term for an aggregate quantity of types in a printing office; as when a work is put in hand, and there happens to be a great quantity of type of the proper sort unemployed, it is usual to say 'there is plenty of letter;' and, on the contrary, 'there is a scarcity of letter.'

Letter of Attorney. [POWER OF ATTORNEY.]

Letter of Credit. A letter written by one merchant, correspondent, or banker to another, requesting him to credit the bearer with a certain sum of money. The bearer should be described with as many particulars as possible, lest the letter fall improperly into other hands. Under the name of *circular notes*, letters of credit are a very convenient form for carrying such money as is necessary for defraying the expenses of travelling, and for avoiding the risk and encumbrance of taking specie. These notes are negotiable at the current rate of exchange with the principal continental bankers.

Letter of License. An instrument by which creditors allow to a party who has failed in his trade time for payment of debts and management of affairs.

Letters of Marque. [MARQUE.]

Letters Patent or **Letters Overt.** In Law, letters of the king, open, but sealed at the foot with the great seal of England, conferring some privilege whereby a party is enabled to do or enjoy that which otherwise he could not. Such are letters patent to make denizens, to protect inventions, &c. [PATENT.]

Lettic. The name for that branch of the Aryan family of languages which includes the old Prussian and the living dialects of Lithuania, Kurland, and Livonia. [LANGUAGE.]

Lettsomite. A hydrated sulphate of copper and alumina occurring in velvety fibres of a smalt-blue colour at Moldawa in the Bannat. It is a rare mineral, named after Mr. W. G. Lettsom.

Lettuce (Lat. lactuca). The garden Lettuce is the produce of *Lactuca sativa.* Lettuces have been arranged in two divisions or groups, namely, *Cabbage Lettuces*, comprising all those which have round leaves, and form a compact depressed head resembling a cabbage; and *Cos Lettuces*, those having firm and crisp upright oblong leaves, folded over one another. The latter are preferred for salads; while the cabbage kinds are preferred for soups. Although containing very little nourishment, lettuces rank with the greatest favourites to be found amongst salad herbs.

Leuchtenbergite. A variety of Chlorite occurring in six-sided pyramids at Slatoust in the Ural.

Leucine (Gr. λευκός, *white*). A product of the decomposition of caseine, called also *caseous oxide* $= C_6H_{13}O_2N$. [APOSEPEDINE.]

Leucite (Gr. λευκός). A crystallised silicate of alumina and potash, of a grey or white colour, generally opaque, and resembling the Garnet in form. It usually occurs in lava, especially in that of Vesuvius; hence it is also termed *Vesuvian* and *volcanic garnet.* This mineral is remarkable as the one in which Klaproth first discovered that potash was a constituent of the mineral kingdom, and not exclusively belonging to vegetables.

Leucocyclite (Gr. λευκός; κύκλος, *a circle*; and λίθος, *stone*). A synonym for Apophyllite. [APOPHYLLITE.]

Leucoline (Gr. λευκός). One of the organic bases of coal tar.

Leucolite. [LEUCITE.]

Leucoma (Gr. λεύκωμα). A white opacity of the cornea of the eye, arising from inflammation. [GLAUCOMA.]

Leucophane (Gr. λευκοφανής, *appearing white*). A silicate of glucina and lime with fluoride of sodium, found in the syenite of Norway, on a small rocky islet near the mouth of the Langesund fiord.

Leucophlegmatic (Gr. λευκός, and φλεγματικός, from φλέγμα, *phlegm*). A pallid flabby state of body.

Leutrite. An indurated sandy marl (which becomes phosphorescent by friction), from the Leutra, near Jena.

Levant (Ital. levante, *rising*). In Geography, a term applied in a general sense to any country situated to the eastward of us, or in the eastern part of any continent or country; but, in a more contracted signification, it is given to that part of the Mediterranean Sea which is bounded by Asia Minor on the north, Syria and Palestine on the east, Egypt and Barca on the south, and by the island of Candia and the rest of the Mediterranean on the west.

Levant Nut. One of the commercial names of the berries of *Anamirta Cocculus.*

Levari Facias (Lat. *cause to be raised*). In Law, a writ of execution directed to the sheriff, whereby he is commanded to levy a sum of money upon the lands and tenements, goods and chattels, of a man who has forfeited his recognisances. It is superseded in practice by the writ of elegit, except in cases of outlawry.

Levator Muscles. In Anatomy, those muscles which lift the part to which they are attached.

Levée (Fr. from lever, Lat. levare, *to raise*). The term used in court language for the ceremonial visits which distinguished personages receive in the morning; or, as the word implies, at their *rising.* It is chiefly applied in this country to the stated public occasions on which her majesty receives visits from such of her subjects as are entitled by rank or fortune to the honour. The difference between a *levée* and a *drawing-room* consists in this, that while at the former gentlemen alone appear (with the exception of the chief ladies of the

court), both ladies and gentlemen are admitted to the latter.

Levée. A bank raised by the side of a river to confine the waters in case of inundation from the effects of a sudden freshet or thaw. The banks of the Po, the Loire, the Rhine, and those of the Mississippi are defended in this manner, which has sometimes a tendency to raise the bed of the river above the level of the surrounding country.

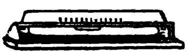
Levée en Masse (Fr. literally *a universal rising*). A Military expression for the rising of a whole people to defend their country from invasion. In Germany it is styled *landsturm*, in contradistinction to the LANDWEHR or MILITIA [which see]; and there, as in Spain and the Tyrol, its efforts have often proved instrumental in rescuing the country from foreign invasion.

Level (Ital. livella = Lat. libella—dim. of libra—*a plummet*: the old French livel, liveau, has been changed into nivel, niveau). An instrument which shows the direction of a straight line parallel to the plane of the horizon.

The plane of the sensible horizon is indicated in two ways: by the direction of the plummet or plumb-line, to which it is perpendicular; and by the surface of a fluid at rest. Accordingly, levels are formed either by means of the plumb-line, or by the agency of a fluid applied in some particular manner. They all depend upon the same principle, namely the action of terrestrial gravity.

Levels in which the plumb-line forms the essential part are those most usually employed for the common purposes required by bricklayers, masons, carpenters, &c. They are constructed under many different forms; but the general principle is as follows: A frame or board is prepared, having one edge perfectly straight, and a straight line is drawn on the frame at right angles to the straight edge. To some point of this straight line a thread carrying a plummet is attached; consequently, when the frame is placed in such a position that the thread of the plummet, hanging freely, coincides with the straight line, the straight edge of the frame, which is perpendicular to it, must be horizontal. [PLUMMET.]

Spirit Level.—By far the most convenient and also the most accurate level is the spirit level, represented in the annexed figure; 'which is nothing more than a glass tube nearly filled



with a liquid (spirit of wine being now generally used, on account of its *mobility* and not being liable to freeze), the bubble in which, when the tube is placed horizontally, would rest indifferently in any part if the tube could be made mathematically straight; but that being impossible to execute, and every tube having some slight curvature, if the convex side be placed upwards the bubble will occupy the higher part, as in the figure (where the curvature is purposely exaggerated). Suppose such a tube as A B firmly fastened on a straight bar C D, and marked at *a b*, two points distant by the length of the bubble; then, if the instrument be so placed that the bubble shall occupy this interval, it is clear that C D can have no other than one definite inclination to the horizon; because, were it ever so little moved one way or other, the bubble would shift its place, and run towards the elevated side. Suppose now that we would ascertain whether any given line P Q be horizontal; let the base of the level C D be set upon it, and note the points *a b*, between which the bubble is exactly contained; then turn the level end for end, so that C shall rest on Q, and D on P: if

then the bubble continue to occupy the same place between *a* and *b*, it is evident that P Q can be no otherwise than horizontal; if not, the side towards which the bubble runs is highest, and must be lowered. Astronomical levels are furnished with a divided scale, by which the places of the ends of the bubble can be nicely marked.' (Herschel's *Astronomy*, p. 92.)

With proper care they can be executed, it is said, with such delicacy as to indicate a single second of angular deviation from exact horizontality.

Levellers. In English History, a party which arose in the army of the Long Parliament, about the time when it overawed that assembly, and transferred the king to Hampton Court, in 1647. The levellers professed, what their name implied, a determination to level all ranks, and establish an equality in titles and estates throughout the kingdom. Several of the officers belonging to this party were cashiered in 1649; and, on Cromwell's departure for Ireland in the end of that year, they raised mutinies in various quarters occupied by the army, and were put down by Fairfax with some bloodshed. John Lilburne, one of the chiefs of the faction—of whom it was said that 'if none but he were left alive in the world, John would quarrel with Lilburne'—published in 1649 his *Manifestation from J. Lilburne and others styled Levellers.* (Clarendon, books x. & xii.; Godwin's *History of the Commonwealth.*)

Levelling Staves. Instruments used with the spirit level, for supporting a mark, and showing at the same time its height above the ground. As constructed by Troughton, they consist of three sliding rods of mahogany, each about four feet long, and divided into feet and hundredths. They carry each a circular sliding vane, having at the lower edge a square aperture, one side of which is levelled; and a line on the levelled side denotes the reading of the staff. The face of the vane is made of white holly, with an inlaid lozenge of ebony, forming at once a conspicuous object and one easy of bisection. In levelling, the vane must be moved up or down till the horizontal wire of the telescope bisects the acute angle of the lozenge, as shown in the

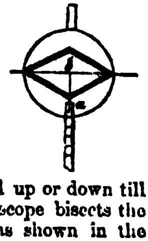


figure. As the line on the levelled edge at *a* denotes the reading of the staff, a piece equal in length to the distance *a b* is cut off from the bottom of the staff, or, rather, the divisions commence at that number of inches above zero. (Simms's *Treatise on Mathematical Instruments*, 1834.)

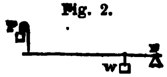
Lever (Fr. levier, from Lat. levare, *to raise*). In Mechanics, an inflexible rod movable about a *fulcrum* or prop, and having forces applied to two or more points in it. The lever is one of the mechanical powers; and, being the simplest of them all, was the first that was attempted to be explained. Its properties are treated of by Aristotle; but the first accurate explanation was given by Archimedes, in his treatise *De Equiponderantibus*.

In treating of the lever, it is convenient to distinguish the forces applied to it by different names. One is usually called the *power*, the other the *weight* or *resistance*.

Levers are commonly divided into three kinds,

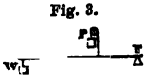
Fig. 1.

Fig. 2.



according to the relative positions of the power, the weight, and the fulcrum.

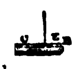
Fig. 3.



In a lever of the first kind (fig. 1), the fulcrum F is between the power P and the weight W. In a lever of the second kind (fig. 2), the weight W is between the fulcrum F and the power P. In a lever of the third kind (fig. 3), the power P is between the fulcrum F and the weight W.

The general principle of the lever is, that, when the power and weight are in equilibrio, they are to each other inversely as their distances from the fulcrum. This property is almost an obvious consequence from the principle of virtual velocities; but it may be deduced from more familiar considerations. Let AB be a cylinder or bar of homogeneous matter. If supported from the middle, O, the two ends would evidently balance each other, and the pressure at O would be the same as if

Fig. 4.



the whole matter of the bar were concentrated in that point. Suppose it to consist of two parts, A C and B C, these again would be separately supported at their middle points D E; or the whole of the matter in A C may be conceived to be concentrated at D, and the whole of that in B C at E, and the equilibrium would not be disturbed. Hence the weight of A C attached at D, and the weight of B C attached at E, would balance the inflexible line D E, if supported at O, the centre of the whole bar A B. But $OD = AO - AD = \frac{1}{2}AB - \frac{1}{2}AC = \frac{1}{2}BC$; and $OE = OB - EB = \frac{1}{2}AB - \frac{1}{2}CB = \frac{1}{2}AC$; consequently O D is to O E as B C to A C; or O D is to O E as the weight concentrated at E to the weight concentrated at D. This demonstration is commonly ascribed to Archimedes. (Maclaurin's *Account of Newton's Principia*.)

This proposition shows the advantage obtained by using the lever as a mechanical engine. The arm P F (fig. 1) is commonly longer than W F, and, consequently, when there is equilibrium, the weight exceeds the power. The proportion in which the weight exceeds the power is called the *mechanical advantage*, or purchase. Suppose P F (figs. 1 and 2) = 4 feet, and W F = 1 foot; then a power of 1 lb. acting at P will overcome a resistance of 4 lbs. at W.

Suppose the lever with the weights P and W to turn round the fulcrum, the two points to which P and W are attached will describe arcs proportional to the radii F P, F W; consequently the power P is to the weight W as the velocity of the weight to the velocity of the power. Therefore in this, as in all mechanical engines, when a small power raises a great weight, the velocity of the power is much greater than the velocity of the weight; and what is gained in force is therefore said to be lost in time.

When the power and the weight do not act on the lever in directions perpendicular to its length, or when the arms of the lever are not in the same straight line, or are bent, then the power and the weight are not to each other reciprocally as the arms of the lever, but as the straight lines drawn from the fulcrum perpendicular to the respective directions in which the power and the weight take effect.

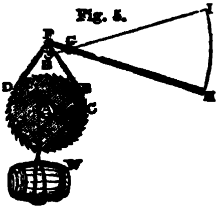
Examples of the application of the lever are of constant occurrence in the mechanical arts. The crowbar, the handspike, the poker, scissors, nippers, pincers, &c. are levers of the first kind; the toothed hammer is only a bent lever of this kind. The second kind includes the chipping knife, nutcrackers, the common door, oars and rudders, the wheelbarrow, &c. To levers of the third kind belong the sheep-shears, the treddle of the turning lathe, tongs, &c.: these have a mechanical disadvantage, but admit of a proportionally wider motion. The bones of animals are generally levers of this sort. The socket of the bone is the fulcrum; a strong muscle attached to it near the socket is the power; and the weight of the limb, with whatever resistance is opposed to its motion, is the weight. A very moderate contraction of the muscle thus gives considerable motion to the limb.

From the principle of the lever is deduced the distribution of pressure in the case of a pole bearing an intermediate weight. If the weight hang from the middle, the carriers will share the burden alike; but if a load is laid over the pole, and a vertical from its centre of gravity divides the length unequally, as will be the case on altering the inclination of the pole (for example, in climbing a hill), then the bearer nearest to whom the vertical falls suffers a greater strain than the other.

Universal Lever is the name given to a machine formed of a combination of the lever with the wheel and axle, the object of which is to give a continued rectilinear motion to a heavy

body by means of the reciprocating motion of the lever. F G H is a straight line, whose centre of motion is at G. At the extremity of its shorter arm hang two bars, the former of which has a hook to catch into the teeth of the wheel A C D, while the latter has its end bent in order to slide over the outer parts of those teeth. The axle A has a cord wound round it, to the end of which is attached the weight W. Now suppose the end H of the lever to be raised from H to I, while the other end descends from F to B; the bar F E will then push the tooth E of the wheel to C, while the hook D slides over an equal space on the other side of the wheel. On bringing down again the end of the lever from I to H, the other extremity ascends through B F, and the hook D raises up the left-hand side of the wheel through a space equal to E C. Thus the reciprocating motion of the lever is made to communicate a continued rotatory motion to the wheel, and consequently to lift the weight W suspended from its axle by the cord. The universal lever has long been employed in saw-mills, for the purpose of drawing along the logs to the saw. (Gregory's *Mechanics*, vol. ii.)

Fig. 5.



Leviathan. The name of a great marine animal in the Book of Job, described in ch. xli. as being covered with close-joined or confluent scales, and having the jaws, or 'doors of the face,' armed with terrible teeth round about. Some naturalists have supposed that the crocodile might be the subject of this description; but the 'breath that kindleth coals' could scarcely be suggested by the respiratory actions of a cold-blooded reptile. The same objection applies to the opinion that the leviathan of Job was the extinct megalosaurus: with this additional difficulty, that the megalosaurus was a terrestrial reptile, as the large medullary cavities of its bones prove; while of the leviathan it is said that 'he maketh the deep to boil like a pot; he maketh the sea like a pot of ointment: he maketh a path to shine after him: one would think the deep to be hoary. Upon earth there is not his like.' These expressions accord well with the violent and impetuous exertions of a huge cetacean in his native element; and the verse, 'Out of his nostrils goeth smoke, as out of a seething-pot or cauldron,' figures not inaptly the 'blowing' of a whale. The teeth of either the cachalot or grampus might well be termed *terrible*; and their external epidermic covering, if considered as analogous to the scales of fishes, would have its distinguishing peculiarities correctly defined by the following expressions: 'His scales are his pride, shut up together as with a close seal. One is so near another, that no air can come between them. They are joined one to another, *they stick together, they cannot be sundered*.' (Verses 15, 16, 17.) Many persons must have witnessed the phenomena of the luminosity of the sea on our own coasts, where it is usually feeble in comparison with that produced in the warmer latitudes of the Mediterranean, or in the tropics. The phenomena which naturalists and voyagers have described as being produced by the swimming and blowing of the cetaceous animals in a phosphorescent ocean, during the night, might likewise have suggested the description of the fire and sparks that escape from the mouth of the leviathan, and of the shining path which he leaves behind him in the deep.

Levigation (Lat. lævigatio, from lævus, *smooth*). The process of reducing substances to a state of fine mechanical division, by mixing them, previously powdered, with water or some other fluid, and rubbing the paste upon a hard smooth slab, with the flat face of a stone called the *muller*. The paste is then often stirred into a large vessel of water, where the coarser powder first falls, and the finer remains suspended, and is afterwards collected by pouring it off with the water, and suffering it slowly to subside. In this way, by repeated subsidences, powders of very different degrees of fineness are obtained.

Levirate (Lat. levir, Gr. δαήρ, *brother-in-law*). A word used in Ecclesiastical Jurisprudence to designate the Jewish custom whereby the brother of a deceased husband was bound to marry the widow; and, in a secondary sense, the marriage of a man with his sister-in-law generally.

Levites. In Jewish History, the descendants of Levi, one of the twelve sons of Jacob, to whom it is stated that no distinct territory was allotted in the land of Canaan, as to the other tribes, because they were set apart for the ministration of the religious services throughout the country, and had forty cities, situated in various parts of Palestine, peculiarly appropriated to their residence. The Mosaic law commanded the tenth of the vegetable produce of the land, and also of the cattle, to be given to them; of this a tenth was set apart for the priests, whose assistants the Levites were. The priests were to be confined to the family of Aaron, who with Moses his brother were both of the tribe of Levi. The classes of which the Levites were composed, their offices, privileges, &c., are enumerated in Num. iii. iv. viii.; also 1 Chron. xxiii.—xxvi.

On this subject the following conclusions are maintained by several recent writers. The historical books of the Old Testament apparently give no evidence of the actual existence of a privileged and powerful sacerdotal caste before the days of the later kings. In the Book of Judges, only two Levites are mentioned, the one being spoken of as belonging to the family of Judah, and wandering about in great poverty until he is appointed by Micah, an Ephraimite, to keep his idols. The other, who seemingly exercises no priestly function, is noticed only in the narrative

which describes an almost complete destruction of the tribe of Benjamin. In the First Book of Samuel, Eli, and his sons Hophni and Phinehas, who are spoken of as priests, belong apparently to the tribe of Ephraim; and their sacerdotal offices are afterwards discharged by Samuel, who seems also to have been an Ephraimite; and, although Samuel rebukes Saul for presuming to offer sacrifice, it is not on the ground that by so doing he was invading the office of an established priestly order. The right of offering sacrifice and of praying for the people is further exercised by David and Solomon; and even under their successors the Levites have no great power or pre-eminence. The full developement of their sacerdotal privileges seems to have followed their return from the Babylonish captivity. (Stanley, *Lectures on the Jewish Church*; Colenso *On the Pentateuch*; Kuenen *On the Pentateuch*.)

Levyne (so called from Levy, the crystallographer). A crystallised mineral found in Ireland, Faroe, and elsewhere, closely allied to the zeolites. It is a hydrated alumino-silicate of lime and soda.

Lewisia (after Capt. M. Lewis). A curious North American Mesembryaceous plant, the Bitter-root plant of the Canadians, and the Spatlum of the Oregon Indians. It has a fleshy root so retentive of life that specimens have been made to grow after having become dried and apparently dead in the herbarium. Hence the species was called *L. rediviva*. The root is eaten by the Indians.

Lexicology or **Lexicography** (Gr. λέξις, *a word or phrase*, and λόγος or γράφω). A word used by some writers to express that branch of philology which treats of words alone, independently of their grammatical and rhetorical uses; considering their senses, their composition, and their etymology. [PHILOLOGY.] There are two useful papers in the *Quarterly Review* on Greek lexicography, vols. xxii. xliv.

Lexicon (Gr. τὸ λεξικόν, sc. βιβλίον, *a book of words*). A dictionary of words, or vocabulary, originally, and still usually, confined to dictionaries of the Greek or Hebrew tongues. The oldest Greek lexicon is the *Onomasticon*, which was written 180 years before Christ: the oldest Hebrew lexicon belongs to the ninth century. [DICTIONARY.]

Leyden Jar. [ELECTRICITY.]

Leze Majesty. In Jurisprudence, any crime committed against the sovereign power in a state. The name is derived from the Roman phrase, *crimen læsæ majestatis*, which denoted a charge brought against a citizen for acts of rebellion, usurpation of office, and general misdemeanours of a political character, which were comprehended under the title of injuries to the 'majesty of the Roman people.' The emperors assigned to all offences against themselves the same criminal character; and offences of leze majesty were multiplied under their arbitrary governments.

Lherzolite. An olive-green variety of Sahlite occurring at Lake Lherz in the Pyrenees.

Liability. [COMPANY.]

Liane. A luxuriant woody climber, like those met with in tropical forests.

Lias (the name *Lias* is supposed to be derived from the appearance of the bed in *layers* in the quarries where it is worked in the middle of England: the term is adopted by geologists of all countries). A remarkable deposit of calcareous clay met with in many parts of England. It generally retains the same mineral form; it is always characterised by similar fossils; and it is traceable by beds very strongly marked. These, in many parts of Belgium, France, and Germany, strikingly resemble the corresponding deposits in the middle of England. Beds of the same age and even of the same kind with similar fossils exist in India, and contemporaneous deposits are very widely spread.

The position of the lias is well marked. It forms the base of the remarkable calcareous group of the middle secondary period, which under the name of Oolitic or Jurassic series is recognised so widely. It overlies the beds which in England are called the *new red sandstone* series (containing salt), and on the Continent the *Triassic* series. It is, however, quite distinct from either.

The contents of the lias and rocks of the liassic series are very interesting and varied. In the middle of England the bands of calcareous nodules, and even calcareous bands of the rock itself, yield an admirable hydraulic cement on burning. They are largely quarried for this purpose. Where the calcareous element is yet more completely observable, as in the marlstone near Cheltenham, the lias yields a good building stone. On the coast of Yorkshire it contains a large admixture of iron pyrites and bitumen, and sometimes there are beds in it approaching the condition of a poor coal or passing into *jet*. The lias shales at Whitby are very extensively worked for the extraction of *alum* produced by a certain amount of manipulation from the decomposition of these shales. Elsewhere the highly bituminous shales are distilled at a low heat for various mineral oils and paraffine; while in some parts of the world, as in various places near the banks of the Danube in Europe, in Virginia in North America, and probably in India, the lias yields considerable stores of valuable fuel, so nearly resembling the true coal of the coal measures as to show no practical difference.

Everywhere, also, the lias is remarkable for its fossils. In England these include a marvellous assemblage of extinct reptiles, of which the ICHTHYOSAURUS, PLESIOSAURUS, PTERODACTYL, and many others, are familiar. Vast multitudes of fishes' remains and numerous characteristic shells also abound. On the whole, there are few more important or interesting deposits known than this liassic series, wherever and however it is presented for investigation.

Libation (Lat. libatio, from libo, *I pour*). The solemn pouring of wine and other liquids in the religious ceremonies of antiquity; in Greek *σπένδειν*. The libations were usually of unmixed wine; but were sometimes mingled, as wine, oil, honey, &c., with water. The libation was poured between the horns of victims, on the altar or on the ground. There was also a custom of pouring out a small quantity of wine, by way of libation to the gods, at the commencement of their banquets; and libation for the emperors became common under imperial Rome.

Libavius's Fuming Liquor. Bichloride of tin, obtained by distilling a mixture of one part of tin filings with three of corrosive sublimate. It emits dense white vapours when exposed to air.

Libel (Lat. libellus, dim. of liber, *a book*). In Law, this term signifies almost any malicious publication by writing or printing, or by signs, pictures, &c. Whatever tends to render a man odious or ridiculous, or to lower him in the esteem and opinion of the world, is a libel; and may either be made the subject of a civil action for compensation in damages to the individual injured, or, as having a tendency to excite his wrath, and provoke a breach of the peace, may be proceeded against by indictment or criminal information. Where it is sought to make a party responsible in damages for a libellous publication, he may set up the truth of it as an answer to the complaint; for the plaintiff, if really guilty of the misconduct or other thing imputed to him, is not considered to suffer by its disclosure any private injury which can be a legitimate ground of compensation to him; but when the proceeding is by criminal prosecution, the truth is no defence whatever, as being altogether immaterial; for the libellous matter may equally provoke a breach of the peace, whether it be true or false. The court, however, will, in general, before granting a rule for a criminal information, which supersedes the usual practice of a presentment by the grand jury, require the prosecutor to deny on affidavit the truth of the matters charged against him. It will be seen, however, that there is not in any case a legal foundation for the maxim vulgarly ascribed to the law, 'The greater the truth, the greater the libel.' All publications are libels, and criminally punishable as such, which have a tendency to disturb the public peace, the government, the established religion, public morals, or the administration of justice. Before the 32 Geo. III. c. 60 (Fox's Act), on a criminal trial for libel the jury were not allowed to take the whole question into consideration, and return a general verdict of guilty or not guilty; but could only decide upon the fact of publication, and whether the libel meant that which it was alleged in the indictment to mean; the court alone taking upon itself to determine the criminality or innocence of such meaning. Now, however, in libel, as previously in all other criminal cases, it is competent to the jury to apply their judgment to the whole question, and return a general verdict of guilty or not guilty. The Act of 6 & 7 Vict. c. 96, commonly called Lord Campbell's Act, has made various important changes in the law of libel. Under that Act, in a criminal proceeding for libel, the truth of the matters charged may be enquired into, but shall not serve as a defence unless their publication was for the public benefit, and the defendant must in that case show on his pleading the public benefit. In civil actions against proprietors or publishers of newspapers, it may also be pleaded that the insertion was made without malice and without gross negligence, and that they had published, or had offered to publish, a full apology.

Libel. In the Spiritual Courts, the original declaration in a civil action is so termed. [Law, Ecclesiastical.]

Libellulines. A genus of Neuropterous insects, of which the dragon-fly, *Libellula*, is the type. [Agrionidæ.]

Liber (Lat. *bark*). In Botany, the interior lining of the bark of Exogenous plants. It consists of woody tissue in great quantity, and very thick-sided, intermixed with cellular tissue. It appears to be formed annually, at the same time with the concentric zones of wood, and is intended by nature to convey downwards the secretions elaborated in the bark and leaves. It is the principal seat of laticiferous vessels.

The name *liber* was applied by the Romans to the thin coats or rind of the Egyptian papyrus, on which books were written; and hence it passed into a general name for books. [Book.]

Liber. In Mythology. The name given by the Latins to the Greek Dionysus or Bacchus. But the Latin Liber was originally a distinct god, presiding over the fertility of fields, and worshipped along with Libera or Ceres. The name seems to be connected with *liberare* and *libertas*.

Liber Albus (Lat. *the white book*). An ancient book containing the laws and customs of the city of London. It has recently been printed under the direction of the Master of the Rolls.

Liberal (Lat. liberalis). In Politics, a cant name, which has been applied since 1815 to the party in each country which advocates constitutional institutions where they do not exist, or their extension into a more popular character where they do. As a party name, this word was perhaps first adopted in Spain, where the party of the cortes assumed the title of *liberales*, and nicknamed their adversaries by that of *serviles*.

Liberalia (Lat.). A festival, in honour of Liber or Bacchus, during which the Roman youths who had attained the age of seventeen assumed the manly dress, or *toga virilis*.

Libertas (Lat.). In the Mythology of the Romans, the goddess of freedom. By the Greeks she was invoked by the synonymous title Eleutheria. At Rome, her most famous temple, built by T. Gracchus, was situated on

the Aventine Mount. She was represented under the figure of a woman, holding in one hand a cap, the symbol of Liberty, and two poniards in the other. In modern times a cap is also used as a symbol of Liberty: thus, in France a red cap formed the badge of the Jacobin Club. In England a blue cap with a white border is used as a symbol of the constitutional freedom of the nation, and Britannia sometimes bears it on the point of her spear.

Libertines (Lat. libertini). In Church History, a name given, in England, to the early Anabaptists, about the middle of the sixteenth century. [ANABAPTISTS.]

Libertini. [FREEDMEN.]

Libertus. [FREEDMEN.]

Liberty (Lat. libertas). Like many other complex subjects involving problems not all of which can be regarded as definitively solved, liberty may be better defined by determining what it is not, than by attempts to lay down what it is. The distinction between rulers and subjects is obviously incomplete, for the relations of subjects or of the members of a community to each other furnish not less important matter for consideration, and in our own day more particularly force themselves on our attention.

When a state is governed by a ruler not responsible to his subjects, it is clear that there can be no such thing as political liberty; but this absolute authority may be exercised by a monarch who has received his power by inheritance or by a usurper who has set himself above law. Among the former may be classed the kings of Eastern nations; among the latter are to be reckoned those who, like Polycrates, Lygdamis, or Pisistratus, rise to power by repressing or subverting an existing constitution. Both these classes of rulers might be equally despotic, but between them the Greek drew a sharp line of distinction. The former were *βασιλεῖς*, kings by right of birth or by choice of the nation, and their subjects owed them an obedience the extent of which was not accurately defined, and which practically had no limits. The latter (however beneficent in practice) were *τύραννοι*, tyrants, whom no one was bound to obey any longer than he could help, and whom every citizen was justified by every means in his power, open or secret, to injure or slay. As they were regarded simply in the light of wild beasts who had broken into a sheepfold, tyrannicide became a duty, and the practice founded on the doctrine received the sanction of public opinion. This distinction is of the greatest importance in Greek history, as explaining the very different language which Greek thinkers applied to such of their enemies as Darius and his son, and to such rulers as the Dionysii of Syracuse.

But in Greece the idea of a more extended liberty was early developed. At Sparta, where the highest titular office was filled by two kings representing the elder and younger branches of the Heracleids, the predominant power of the ephors left the kings little more than a military command in time of war. But the system administered by the ephors, although depending on the national will, was, as it affected the individual citizen, to all intents and purposes a despotism. It regulated not only all public, but also all private concerns; it interfered with families, and separated the members into classes, who thenceforth existed as a mere political relation; it substituted for domestic life a life of clubs, subjected to a strict routine of employment and the severest sumptuary laws; it placed its ban on all literature, and confined all education to that of the body, and to an absolute submission of the will to a stereotyped order of things. But as the people willed to have it so, the nation was collectively free. The idea of individual freedom was distinctly recognised first at Athens; and if we take the funeral oration of Pericles (Thuc. ii. 35) as a fair exposition of that idea, we can scarcely withhold the admission that the highest modern civilisation has scarcely reached the standard there set forth. In the elaborate comparison which he makes between the polity of Athens and that of Sparta, he lays most stress on the unbounded freedom which the citizens of the former state possessed in the indulgence even of whims and caprices of taste and fancy. According to that picture, every citizen has a right not only to be represented in the government, but to take a personal share in it [PRIMARY ASSEMBLIES]; he has the power of arranging his family, decorating his house, and furnishing his table as he pleases; he is free from all drill and routine, and is not required to prepare himself against the accident of war, by giving up the cultivation of all elegance and grace in times of peace. He may read what books he pleases, and he is free to express whatever opinions he may entertain. The result of this Pericles affirms to be, that Athenian citizens are not surpassed by those of any other states for bravery, presence of mind, and the versatility which is ready to face any emergency, while they are altogether unequalled in their literature and in their appreciation of science and art. An Englishman on reading this account might be forgiven if he saw in it a picture of the civilisation of his own country as compared with that of those continental states of Europe which approach nearest to it in constitutional government. But it must be remembered that the perfect equality of Athenian citizens was, after all, only the equality of an oligarchy, and that it rested on the permanent subjection of a far larger class, in whom a later philosophy saw nothing but animated instruments or machines (*ἔργανον ἔμψυχον*, Aristotle, *Pol.* i. 4. 2). But when all the necessary allowances have been made, it must be admitted that the downfall of the Athenian state closed the brief era of individual freedom, until the seed, long buried, began again to grow within the last few centuries of European history. For, in Rome, the rights and interests of the individual man were but little consulted, and his personal tastes, predilections, and as-

pirations were at once set aside if they interfered with the interests of the state. This complete subordination of personal to public interests is, perhaps, the secret of the rapid conquests of the republic; but it left all the questions relating to the liberty of the individual citizen altogether unsolved.

With these questions the philosophy of Aristotle dealt in a summary fashion, which presents a complete contradiction to the ideal or the actual polity of Pericles. According to his system, each man is free who lives in a free state, i. e. a state which is not subjected to foreign rule, and which gives to him a share in the administration of the laws. But the power of this state is not limited to the public relations of the citizens. The ethical system of Aristotle is only a part of his political system, and is of value in his eyes only as enabling each man to discharge his duties as a citizen. The state is, therefore, not only justified, but bound to regulate the education and private life of all its members: it is to dictate to them what they are to learn and do, the books which they are to read, and the tastes which they should cultivate. There is, consequently, an imperative need of the most minute legislation for all the circumstances of life (περὶ πάντα τὸν βίον, *Eth. N.* x. 10); and this legislation will be obeyed by all decent-minded persons from the mere principle of obedience to law as such. Those who cannot rise to this standard of action will resist; and for these there are pains and penalties which are exactly opposed to the selfish pleasures which they love. The resemblance of this doctrine to that of St. Paul is manifest; but the upshot is that good citizens, in obeying the law, receive their reward in the satisfaction of their own consciences. They have acted as they have done τοῦ καλοῦ χάριν, from a disinterested love for that which is beautiful: and this is the highest pleasure to which they can attain. It is, however, an ideal pleasure, with which the positive penalties assigned to wrong action stand out in grim contrast.

Still, for all practical purposes, the province of executive government remains much the same in England now as it was in Greece in the days of Aristotle. It is no part of the business of the state to reward good actions as such. Any harm done to the persons or the property of others, it will promptly repress and punish; but for the performance of the most beneficial and self-sacrificing acts it will leave the citizen, as Aristotle left him, to the approval of his own heart. It becomes, therefore, a matter for simple astonishment when we find such a writer as Bishop Butler deliberately asserting that 'the annexing pleasure to some actions and pain to others, in our power to do or forbear, and giving notice of this appointment beforehand to those whom it concerns, is the proper formal notion of government' (*Analogy*, part i. ch. ii.); and it may fairly be regretted that he should thus, in the supposed interests of a theological dogma, have laid down as true in fact a definition which no nation or government has so much as attempted to realise. Certainly, Butler himself did not live in an age in which parliament periodically ordered all persons to feel pleasure for all good deeds which they may have done, and still less offered them the means for procuring this pleasure.

But the progress of modern thought and civilisation tends more and more to restrict the function of government to the protection of person and property. It is felt, therefore, more and more, that with morality and religion, as such, the state has nothing to do; and it is acknowledged that sumptuary or other enactments, designed to regulate the private tastes and habits of citizens, trench on a province which is wholly beyond the reach of human law. Such restrictions, in the measure in which they take effect, necessarily enlarge proportionally the liberty of the individual citizen, and force on our attention those further questions which are discussed at length in Mr. J. S. Mill's work on *Liberty*.

But without attempting to enter on discussions wholly beyond our limits, we may remark that a very real obstacle is placed in the way of personal liberty where all the members of a state, without respect of office and position, are not equally amenable to the law of the land. In this respect, the British constitution stands out in favourable contrast with the most free constitutions of Europe; for whereas in this country all judges and magistrates are liable to prosecution not less than the meanest member of society, under the continental governments no charge can be brought against subordinate officials, of whatever kind, without the written permission of the chief in the department or bureau to which he belongs, while against the chief himself the application of a legal remedy is still more difficult and uncertain. Where this privilege exists, the essential conditions of individual liberty are lamentably imperfect, even if that liberty is not wholly neutralised. This state of things is productive of the greatest mischief in the smallest and the least powerful states, and may be set down as one of the chief causes of that chronic misgovernment under which the modern Hellenic kingdom seems likely to labour for many years to come. Wherever it exists, it must operate as a formidable barrier in the way of that free expression of opinion on all subjects which seems to be of the very essence of political and social freedom. (Mill *On Liberty*, ch. ii.) [REPRESENTATION.]

LIBERTY. In Philosophy. [NECESSITY.]

Libethenite. A native phosphate of copper, found in cavities in Quartz, at Libethen, in Hungary, associated with Iron Pyrites.

Libitina (Lat.). An Italian goddess, in whose temple, at Rome, was deposited a small coin, called *Libitinai ratio*, for every person who died. This custom, which originated in the desire to procure a faithful account of the number of deaths, may, perhaps, be regarded

as among the first attempts to obtain an accurate census of the population.

Libocedrus (Gr. λίβανος, *incense*; κέδρος, *the cedar-tree*). A genus of Chilian and New Zealand *Coniferæ*, related to *Thuja*. *L. Doniana*, the Kawaka of New Zealand, is a large tree, yielding a fine-grained heavy timber; while *L. Bidwillii*, from the same country, has wood so soft and porous that soap bubbles may be blown through a piece a foot long. The Chilian *L. tetragona* and *L. chilensis* are valuable timber trees. The grain of the former is so straight and equal, that the wood can be split into shingles which look as though they had been dressed.

Libra (Lat. *the balance*). One of the zodiacal constellations, the seventh in order, beginning with Aries. Libra is one of the forty-eight ancient constellations of Ptolemy.

Libra denotes also the ancient Roman pound. [Weights.]

Libraries, Itinerating. The name given to a peculiar species of circulating library, instituted a few years ago at Haddington, in Scotland, by Mr. Samuel Brown. The principle on which such libraries are formed consists, as the epithet *itinerating* implies, in the books being sent from one part or district of a country to another on the following plan: The books are formed into divisions, consisting each of a certain number of volumes, and proportioned in number to the extent of the country intended to be supplied. Each division remains for a certain period (in some instances one or two years) in the same place, when it is removed to another, and succeeded by a new supply of books of the same number; by which means each place has a fresh supply of useful reading at short stated intervals. In Haddingtonshire, which may be called the head-quarters of itinerating libraries, the books consist of 43 divisions of 50 volumes each: and on the principle above explained each volume, at an average of the 43 divisions, is read *five* times during two years, the period at which the books are changed. The system of itinerating libraries has been extended to various other parts of Scotland, to several districts of England, to Ireland, Canada, South Africa, and Jamaica. The use of the books is gratuitous, if so wished; and never more than a penny per annum has been systematically taken from any reader. Voluntary contributions, however, either in books or money, are received. (*Geographical Dictionary*, art. 'Haddington.')

Library (Lat. liber, *book*). The name given either to a collection of books, or to the apartment or edifice in which they are kept. The most famous of ancient libraries was that of Alexandria. Its history has been written by Bonamy (*Mém. de l'Acad. des Inscr.* vol. ix.), Reinhard (Götting. 1792), and many others. It was first formed by the Ptolemies, Soter, Lagides, Philadelphus and Euergetes; the last of whom resorted to very royal measures for the accomplishment of so laudable an end; for he is said to have seized on books imported from Greece, caused them to be copied, and returned the copies to the proprietors, keeping the original for his library. The collection of Soter is said to have been deposited in a suburb called Bruchium, which was burnt by the troops in Cæsar's Egyptian war. That of Philadelphus (the smaller of the two) was preserved in the temple of Serapis, and became the nucleus of the later library, which was augmented by the great library of Pergamus (said to have amounted to 200,000 volumes), presented to it by Mark Antony. The narrative of the destruction of this library by the fanatical Arabs, in A.D. 641, is among the popular chapters of history; and the most careful enquirers are of opinion that it is substantially, if not literally, true, notwithstanding the doubts thrown on it by Gibbon and others. The first public library at Rome was founded by Asinius Pollio; the second, the Palatine, by Augustus; great part of it was consumed under Commodus; but much remained even in the time of Constantine. Reusch (1734), Eckerman (1764), and Eckhart (1799), have published separate dissertations on the libraries of the Romans. The ancient libraries of the West must have wholly perished in the convulsions which attended the overthrow of its empire. The history of those of the East is not easy to investigate. Constantinople certainly possessed, at the period of its capture, extensive remains of ancient literature; and many, but almost wholly fruitless investigations, have been made of late years in the monastic libraries of modern Greece, particularly of Mount Athos, for valuable manuscripts. (Walpole's *Oriental Memoirs*; *Journal of Education*, vol. ii.; Curzon's *Monasteries of the Levant.*) The best accounts of ancient libraries to which we are able to refer the reader, are contained in the work of Petit Radel, *Récherches sur les Bibliothèques Anciennes et Modernes*; Heeren, *History of the Study of Classical Literature*, vol. i.; Ersch and Gruber's *Encyclopædia*, art. 'Bibliotheken;' Taylor's *History of the Transmission of ancient Books in modern Times*; *Ency. Brit.* art. 'Library.'

Of modern public libraries, the most celebrated is that of Paris (Bibl. Impériale). It was commenced by King John, in the middle of the fourteenth century, with *ten* volumes; and has been augmented by subsequent kings to the enormous number which it now possesses. (Le Prince, *Essai Historique sur la Bibl. du Roi*, Paris 1787.) In Italy, the Ambrosian at Milan, and the Vatican at Rome, are peculiarly rich in MSS. But the most extensive are those of the British Museum. That of Oxford (the Bodleian) is peculiarly rich in Oriental manuscripts. That of the Advocates, at Edinburgh; and of Trinity College, Dublin, are extensive. Statements of the number of books contained in public libraries will be found in many works; but no statistical information is more imperfect and worthless.

Premising thus much as to the uncertainty of our materials, we offer the following estimate of the contents of some of the principal libraries of Europe.

Great Britain.—British Museum (1864), 780,000 printed volumes (the additions now exceed 40,000 per annum), MSS. (1864) 30,800. Bodleian, Oxford, printed volumes (1862) 400,000, MSS. 30,000. Advocates', Edinburgh (1857), 172,000.

France.—Impériale (1862), more than 500,000 printed, besides 450,000 pamphlets or sheets, 84,000 MSS.

Germany.—Munich, probably from 400,000 to 500,000 printed, 10,000 MSS. Vienna (1853), 365,000 printed, 20,000 MSS. Berlin, 460,000 printed, 10,000 MSS. Göttingen (1850), 300,000 printed, 6,000 MSS. Dresden (1853), 305,000 printed.

Italy.—Vatican, 150,000 printed, 40,000 MSS. Public Library, Naples, 200,000 printed, 4,000 MSS.

Russia.—Imperial of St. Petersburg (1857), 520,000 printed, 21,000 MSS. Denmark, Copenhagen, 408,000 printed, 15,000 MSS.

Libration (Lat. libratio, from libra, *a balance*). In Astronomy, a term applied to certain phenomena connected with the moon's motion.

The libration is of two kinds; the libration in longitude and the libration in latitude. The libration in longitude, by which we are enabled to look a few degrees round the equatorial parts of her eastern and western limbs, is occasioned by this circumstance, that the rotatory motion of the moon about her axis is not always precisely equal to the angular velocity in her orbit. If the moon's orbital motion were uniform, and performed in the same time as her rotation about the axis, the radius vector from the centre of the earth would always intersect the lunar disc in the same point, or the moon would always present exactly the same face to the earth. But the rotatory motion is sensibly uniform; while the orbital motion, being performed in an ellipse, is sometimes slower and sometimes faster than its average amount. Hence the spots near the eastern and western borders alternately disappear and reappear.

The libration in latitude is occasioned by the inclination of the moon's axis of rotation to the plane of her orbit. Supposing this axis always to have the same direction in space, the angle which it makes with the radius vector of her orbit will be acute during one part of her revolution and obtuse in another. Hence the two poles of rotation, and the adjacent parts of the surface, are alternately visible from the earth.

License (Lat. licentia). In Law, a power or authority given to a man to do some lawful act, and conferred either by word or by deed. If a man abuse a license or authority given to him by the law except in distraining for rent, with respect to which special statutory provisions have been made, he becomes a trespasser ab initio. License is also commonly taken for the admission of an individual, by proper authority, to the right of doing particular acts, practising in professions, &c., and for the certificate of such admission.

Licentiate. A degree in some foreign universities; but not known in the universities of England, except in the instance of the degree of licentiate in medicine, which is granted at Cambridge. In the original sense of the word it appears to have been a title applied only to such as had obtained a license to teach. It is said to be of Italian origin, and first granted at the university of Bologna. Where the degree of licentiate exists, it intervenes between that of bachelor and that of doctor.

Lich Gate (Ger. leiche, *a corpse*). A shed over the entrance of a churchyard, or a cemetery, beneath which the bearers of the corpse sometimes rested.

Lichanus (Gr. λείχω, *I lick*). The forefinger, used in tasting a small quantity of anything.

Lichen (Gr. λειχήν, *a roughness of the skin*). In Pathology, a papulous eruption of the skin, terminating in scurfy exfoliations: it is generally symptomatic of disordered stomach and bowels.

Lichens (Gr. λειχήν). A very extensive natural group of Cryptogams of a very low organisation, which grow on the bark of trees or rocks, when they form a kind of incrustation; or upon the ground, when they consist of irregular lobes parallel with the earth's surface. Occasionally in all situations they are found in a branched state; but their subdivisions are generally irregular and without order. Their fructification consists of hard nuclei, called *shields*, which break through the upper surface of the *thallus* or main substance of the lichen, are of a peculiar colour and texture, and contain the reproductive particles.

Lichens abound in the cold and temperate parts of the world. The greater part are of no known use; but some, as the reindeer moss (*Cenomyce rangiferina*), the Iceland moss (*Cetraria islandica*), and various species of *Gyrophora*, are capable of sustaining life, either in animals or man. The Iceland moss, when deprived of its bitterness by boiling, becomes, indeed, a diet recommended to invalids. Others are used as tonic medicines, as *Variolaria faginea*, and *Parmelia parictina.* Their principal use is, however, that of furnishing the dyer with brilliant colours; orchil, cudbear, and perolle, with many more, are thus employed.

Lichens, Colouring Matters of. Lichens or liverworts are diminutive mossy-looking plants frequently found on old walls, the trunks of trees, &c. in most countries. They all contain definite crystalline substances which become coloured on exposure to a moist warm atmosphere containing ammonia. Foreign lichens are especially rich in these matters, 100,000*l.* worth being annually imported into this country, chiefly from the Canary Islands, for the purpose of making the well-known lilac,

blue, violet and purple dyes known as *archil*, *cudbear*, and *litmus*. The following is a list of the lichen derivatives; they were nearly all discovered by Stenhouse and Schunk, and the chief of them are treated of in separate articles: Amarythrin, asoerythrin, beta-orcin, chlororcein, chrysophanic acid, erythrellic acid, erythric acid, erythroleic acid, erythro-mannite, evernic acid, everninic acid, gyrophoric acid, lecanoric acid, leucorcein, litmic acid, litmylic acid, nitro-erythro-mannite, orcein, orcin, orsellic acid, parellic acid, picroerythrin, pseuderythrin, procellinin, spaniolitmin, telerythrin.

Lichenic Acid. The acid peculiar to some species of lichens. It appears to be the *malic acid*.

Lichenin. A substance closely allied to starch, extracted from the *Cetraria islandica*, or Iceland moss.

Lichenstearic Acid. A crystalline oily body contained in Iceland moss.

Lichtenberg's Figures. When the knob of a charged Leyden phial is drawn over a flat surface of lac or resin, as, for instance, the plate of an electrophorus, it leaves a charge in its track, positive or negative, as we choose; and if, after this, a mixture of certain powders be sifted upon the plate, as, for instance, of powdered sulphur and red lead, the sulphur will adhere to the one and the red lead to the other electrified surface, and with a little management groups of figures resembling flowers may be thus brought out, as Lichtenberg first observed.

Licks. A term applied in North America to sandy tracts of land, upon which common salt forms an efflorescence, and which almost all graminivorous animals resort to for the purpose of licking the surface.

Lictors (Lat. lictores). Officers who attended the principal Roman magistrates (such as the consuls, master of the horse, and prætors) and the vestal virgins on their appearance in public. Their insignia were the *fasces* or bunch of rods (originally encircling an axe, which within the walls of Rome was used under the republic only by dictators), and the *virga* or rod, which was used to touch the door of the magistrate on returning home. The number of lictors in attendance varied according to the rank of the magistrate; thus the consuls had twelve, the prætors six, and dictators, according to some, twenty-four.

Licuala (its Macassar name). A genus of palms from India and the Indian Archipelago, one species of which, *L. acutifida*, yields the walking sticks known by the name of *Penang lawyers*. The stems average about an inch in diameter, and five feet or more in height.

Liebenerite. A pseudomorphous form of Elæolite.

Lieberkühn. A silver concave reflector fixed on the object-glass end of a microscope to bring the light to focus on an opaque object.

Lieberkühnian Glands. In Anatomy, simple secerning cavities, having the form of blind tubular depressions of the intestinal mucous membrane, thickly distributed over the whole surface of the large and small intestines. They are so called after their discoverer Lieberkühn, who observed them in the small intestines, where they are visible only with the aid of a lens, their orifices appearing as minute dots scattered between the villi. They are larger in the large intestine.

Liebigite. A hydrated carbonate of uranium and lime occurring in mammillary concretions or thin crusts of an apple-green colour, near Adrianople in Turkey, and also in Saxony and Bohemia. Named after Baron Liebig.

Liege (in the Latin of the middle ages ligeus, perhaps from ligare, *to bind*; some writers derived the word *liege* from the Teutonic word *leude*—Mod. Ger. leute, *people*—used in the sense of *vassal*). A liege lord, in feudal language, is a superior to whom *allegiance* is owed, and a *liege-man* he who owes such allegiance. Hence all subjects are termed *lieges* of the king.

Lien (Fr. *a bond*). In Law, the right which a creditor has to retain the property of his debtor until the debt has been paid. It furnishes one of very few instances in which a party is allowed to take the law, as it were, into his own hands. Liens are either general or particular. A general lien is the right to retain a thing for a general balance of accounts, and not for those demands only which arise in respect of the thing retained. This sort of lien is not favoured by law, as having a tendency to prefer one creditor to another. A particular lien, which the law is said to favour, is a right to retain a thing when the claim against the owner of it arises out of the thing retained itself; as, where a tailor has made the cloth of his customer into a coat, the tailor may retain the cloth until he is paid for his labour in making it into a coat. The payment of a simple contract debt cannot be enforced by action after six years have elapsed from the time the debt was incurred: but a party who has a lien on property may retain it for an unlimited period, until his claim is satisfied.

Lientery (Gr. λειεντερία, from λεῖος, *smooth*, and ἔντερα, *bowels*). A Medical term formerly applied to a form of diarrhœa in which the food passes rapidly through the bowels in an apparently undigested state. Lubricity of the intestines.

Lieutenant (Fr.; from Lat. locum tenens, *holding a place*). In the Army, a commissioned officer next in rank to a captain, in whose absence he takes the command of his company. In the British service the lieutenants of the three regiments of foot guards have the rank of captain. In the marine artillery and marines of the British service, and in all the regiments of most of the Continental nations, there being no cornets or ensigns, the subaltern officers are distinguished as first and second lieutenants. In the royal artillery and engineers there is no commissioned rank lower than that of lieutenant. The daily pay of a lieutenant is:

in the life guards and horse guards, 10s. 4d.; foot guards, 7s. 4d.; cavalry, 9s.; artillery (horse), 9s. 10d.; (foot), 8s. 10d.; engineers, 8s. 10d.; marines and infantry, 6s. 6d.; and the price of his commission, according to the present regulations, is, for the life guards, 1,785l.; horse guards, 1,600l.; foot guards, 2,050l.; cavalry and infantry of the line, 700l.

Lieutenant. In the Navy, the next rank to that of commander, and coordinate with that of captain in the army, or with that of major after being eight years a lieutenant. The number of lieutenants appointed to ships of war varies with their rate. A ship of the first rate carries eight lieutenants, besides supernumeraries; and those of the second, third, fourth rates, &c. have respectively one less than the number appointed to the preceding rate. The daily pay of a lieutenant in the British navy varies, according to the ship, from 14s. 9d. to 10s. His half-pay ranges according to service from 8s. 6d. to 4s. a day.

lonel. A commissioned officer in the army, next in rank to a colonel, and senior to a major. He has actual command of a battalion in the line. [Colonel.]

Lieutenant-General. [General.]

neral of the Kingdom. A dignity equivalent to that of regent, which has been occasionally held in France on temporary emergencies. The count of Artois (afterwards Charles X.) took this title in 1814 on entering France, and held it until the arrival of his brother, Louis XVIII. On the expulsion of Charles X., in 1830, the duke of Orleans was constituted lieutenant-general, both by an ordinance of that prince, and by the provisory government of the Hôtel de Ville, on July 29; and retained the title until he was proclaimed king on August 7 following.

Lièvrite. A silicate of iron and lime, named after the discoverer, Le Lièvre. It has also been called *Jenite* and *Ilvaite*, as being found at Jena and in the island of Elba.

Life (Ger. leben). A living thing has been defined by Professor Owen as an object which possesses such an internal cellular or cellulo-vascular structure as can receive fluid matter from without, alter its nature, and add it to the alterative structure. Such fluid matter is called *nutritive*, and the actions which make it so are called *assimilation* and *intus-susception*. These actions are classed as *vital*, because, as long as they are continued, the organism is said *to live*. Other definitions, formed more or less upon metaphysical bases, have been suggested by physiologists. Bichat defined life as 'the sum total of the functions which resist death,' which has been wittily paraphrased as 'Life consists in being able to live.' Treviranus defined it as 'the constant uniformity of phenomena with diversity of external influences;' Lawrence as 'the assemblage of all the functions or purposes of organised bodies, and the general result of their exercise;' Dugés as 'the special activity of organised bodies;' Béclard as 'organisation in action;' Kant as 'an internal principle of action;' De Blainville as 'the twofold internal movement of composition and decomposition, at once general and continuous;' Herbert Spencer as 'the definite combination of heterogeneous changes, both simultaneous and successive, in correspondence with external coexistences and sequences;' and Mr. G. H. Lewes as 'the dynamical condition of the organism.' The whole question of the correct terminology of the sciences of life is not yet in a sufficient state to be dogmatically decided.

Life Annuity. [Annuity.]

Life Assurance. [Assurance.]

Life Buoy. An apparatus carried on shipboard, piers, &c. for the purpose of throwing to a person who has fallen into the water, to e him to sustain himself until the arrival of assistance. The commonest form is a zone of about thirty-one inches in diameter, six inches wide and four inches thick. It is formed of about twelve pounds of cork in thin layers; the whole being held together by a painted canvas case. Such a buoy will sustain six persons. Some life buoys comprise a short mast to carry a flag for daylight, or a composition which at night burns for some minutes with a powerful light. The object of this arrangement is to attract the attention of the drowning person.

Life Guards. Cavalry troops composing the body guard of a sovereign prince. In England they consist of two regiments, each comprising a total of 440 of all ranks. There is also a regiment of horse guards performing the same duties. In Germany such troops are styled the *leib garde* (body guard); and in France the *garde du corps*. The English name is, therefore, only catachrestic. [Guards.]

Life Line. In a Ship, any rope stretched along for the safety of the men, as is practised in bad weather; also lines attached loosely to a life buoy to give a person in the water more chance of obtaining a hold upon it.

Life, Mean Duration of. [Expectation of Life.]

Life Rent. In Scottish Law, the right of enjoyment either of an heritage or a sum of money, for the life of the life renter. The superior proprietor of the subject, or *fee*, in which this rent subsists, is termed the *fiar*. *Terce* (i. e. dower) and *courtesy* (analogous to the courtesy of England in English law) are instances of legal life rents.

Life-preserving Apparatus. This apparatus, employed to effect communication between a stranded vessel and the shore, consists in our service of a cast-iron shot carrying a leather thong, to which a long line is secured. There are four fuse holes from which flame issues when the shot is fired. Before firing, the fuses are uncapped, and the shot is placed in the bore of the gun base foremost. This apparatus is also known as *Manby's shot*.

Lifeboat. A boat devoted to the saving of life which would otherwise be sacrificed from the violence of the sea. As its service is only in the most tempestuous weather, it is indis-

pensable that it should be of great strength yet moderate lightness, easy of management, and incapable of being swamped. Several designs have received more or less favour, and have each been instrumental in saving many lives. The present lifeboat, as adopted by the Royal National Lifeboat Institution, is the invention of Mr. Peake, now master-shipwright of Devonport Dockyard. It consists of a strong boat about thirty feet long, and eight wide, to give great stability. It is nearly flat-bottomed; but the bow and stern (which are alike) rise about two feet higher than the midship portion. Running along the upper part of each side, and occupying four feet in length of bow and stern, are air-tight chambers which impart buoyancy, and are sufficient to float the boat and crew when filled with water. Should the boat by any chance capsize, it would rest on the raised points of the bow and stern; but as it has a heavy iron keel weighing seven or eight hundredweight, it is very nearly impossible for it to turn over, and if it do capsize it is wholly impossible for it to remain many seconds without righting itself. The iron keel is also of great advantage on taking the beach or grazing a rock. The boat has—and this is its distinctive feature—a false bottom sufficiently raised to be above the water-line when it is fully laden with crew and passengers. The space between the false bottom and the bottom of the boat is tightly packed with pieces of cork and light wood; and passing right through this ballast from the false bottom to the water below are open tubes about six inches in diameter. If a sea be shipped and the boat filled, the water is immediately discharged through the tubes, since the false bottom is above the water-line. The lifeboat is propelled by eight to twelve oars of the best fir: usually rowed double-banked.

For carriage on board ship this land lifeboat is too cumbrous; and, for this purpose, an ingenious folding lifeboat has been invented by the Rev. E. L. Berthon, of Fareham, which readily expands and possesses great strength. It is much used by ocean steamers.

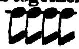
Lift-tenter. The name given in some parts of England to a sort of regulator or governor applied to windmills to counteract the irregular action of the wind. In a windmill for grinding corn, the distance between the upper and lower millstones is regulated according to the velocity; and if, when the mill is at work, the velocity should receive any considerable increase, the corn is forced rapidly through the mill without being sufficiently ground. To prevent this is the object of the lift-tenter. Like the governor of a steam engine, it acts by the centrifugal force of one or more balls which fly out when the velocity is augmented, and as they rise in the arc of a circle, allow the end of a lever to rise with them, while the other end descends with the upper millstone, and brings it a little nearer to the under one.

Lifting Jack. A simple mechanical arrangement for raising one end of the axletree of a carriage, and so lifting the wheel from the ground; the wheel can then be removed, or turned round for the purpose of being cleaned.

Lifting Pump. [Pump.]

Lifts. On Shipboard, the ropes used for hoisting, lowering, and maintaining in position the several yards. They pass in pairs over the head of the mast on which the yard is suspended, and thence to the deck or to the tops.

Ligaments (Lat. ligamentum, from ligo, *I bind*). Strong elastic membranes connecting the extremities of the movable bones. When boiled in water they yield more or less gelatine, and leave a portion of insoluble albumen.

Ligature (Lat. ligatura, from ligo). In Music, the tie which binds several notes of like length together, by which they appear in groups. Thus  four quavers, by means of a ligature at top or bottom, assume the form , the line connecting them being the ligature.

Ligature (Lat. ligo, *I bind*). In Surgery, a waxed thread of silk used in tying arteries or veins.

Ligatures. In Printing, two or more letters cast on one piece or shank. They are also called *logotypes* (word-types), a name given them by the late Earl Stanhope. They have never succeeded in a commercial point of view, although great efforts were made some few years back by Major Beniowski to induce the House of Commons to accept his logotypes for printing their work. The precursor of the *Times* newspaper (the *Universal Register*), as well as the first few numbers of the *Times* itself, were printed with logotypes; and the founder of these journals, Mr. J. Walter, in the first number of the *Register*, published Jan. 1, 1785, tells his readers that he considers the new mode so economical that he can in consequence afford to sell his paper at 'one halfpenny under the price paid for seven out of the eight morning papers.'

The ligatures now in use are few in number, having been reduced to æ, œ, ff, ffi, ffl, fi, and fl; but within the last forty years we had also the ct, ſb, ſh, ſi, ſk, ſl, and ſt, now discarded mainly in consequence of our confining ourselves entirely to the short *s*. The & is the modern form of the &, the *e* and *t* joined together for *et*. Earl Stanhope proposed to abolish the present ligatures by making the f more upright without being kerned, so as to admit an i or an l or another f after it, and to introduce others which occur more frequently, viz. th, in, an, re, se, to, of, and on.

Greek Ligatures.—In former times Greek was printed as written in the middle ages, with an immense number of ligatures, some easily decipherable, but most of them not intelligible even to good Greek scholars of the present day. A list, perhaps the most complete, was compiled by the late Mr. Savage from various sources, and is given in his *Dictionary of Printing*.

Light (Ger. licht, Lat. lux, Gr. λευκός, Sansc. lôk, *to look or see*). The phenomena of light and vision have always been regarded

as one of the most interesting branches of natural science; though it is only since the days of Newton that they have been examined with such care as to afford grounds for any safe speculation respecting the nature of light, and the mode of its propagation through space.

The knowledge of the laws which regulate the phenomena of light constitutes the science of *Optics*, which is divided into a number of subordinate branches. An account of the principal phenomena will be found under the terms ABERRATION, CHROMATICS, INTERFERENCE, OPTICS, POLARISATION, REFLECTION, REFRACTION, &c. The present article will be confined to a brief enumeration of some of the principal properties of light, and a statement of the two theories which have been proposed to explain its nature and propagation.

Properties of Light.—Experiments of the simplest and most familiar kind suffice to show that light is propagated from luminous bodies in all directions. Thus, the flame of a lamp is visible from every part of the sphere of which it occupies the centre; and the same is the case with respect to a phosphorescent body, an electric spark, a ball heated red-hot, or light having any other source. The sun throws its light, not only on the earth, but on the planets, and comets, and every other body in the firmament.

Another property of light is, that in a homogeneous medium it is always propagated in straight lines. This is evident from various considerations. The forms of shadows correctly represent the outlines of the objects which produce them, as seen from the luminous body, which could not be unless the light proceeded in straight lines from the extremities of the objects to the borders of the shadow. If three plates of metal, each pierced with a small hole, are placed at some distance behind each other, and in such positions that the three holes are exactly in one straight line, the light will pass freely through them; but if the holes are not exactly in a straight line, no light will pass. In like manner, if a number of similar objects are placed behind each other in a straight line, the first renders all the others invisible to an eye placed in the same line. We cannot see through a bent tube.

A third property of light is that it requires time for its propagation. The velocity with which it passes from one point to another is, however, so great, that, with respect to any terrestrial distances, the passage may be considered as instantaneous. But astronomy furnishes the means, not only of detecting its propagation, but of measuring its velocity with great precision. The eclipses and emersions of Jupiter's satellites become visible about 16 m. 26 s. earlier when the earth is at its least distance from Jupiter, than when it is at its greatest. Light, therefore, occupies above a quarter of an hour in passing through the diameter of the earth's orbit. Now, the sun's distance from the earth being nearly 93,000,000 miles, it follows that light must travel through space with the prodigious though finite velocity of about 193,000 miles in a second of time, and consequently would pass round the earth in the eighth part of a second. Astounding as this conclusion is, no result of science rests on more certain evidence. It is also proved, by the phenomena of aberration, that the light of the sun, planets, and all the fixed stars, travels with one and the same velocity.

When light in its progress encounters an obstacle, or enters a different medium, it undergoes certain modifications, depending on the nature of the body on which it falls, or the medium into which it enters. When it falls on a smooth polished surface, a portion of it is regularly reflected; that is to say, it is returned from the surface at an angle equal to the angle of incidence, and pursues its course in a straight line as before the reflection. The quantity of light thus reflected depends on the nature and polish of the surface, and on the angle of incidence, the amount being greatest when that angle is small. A polished surface of silver, the most perfect reflector of light known, reflects about 91 per cent. of the incident rays, whilst a polished surface of glass at a small angle of incidence reflects only about 4 per cent. If the medium upon which the light falls be transparent another portion of it enters the medium, and there (if the medium is homogeneous) pursues a rectilinear course, but differing from its former direction, unless the surface of the medium be at right angles to the track of the ray. In this case it is said to be refracted. The angle of refraction depends on the nature of the medium, each different medium having its own peculiar action on light. In many media, comprehending the liquids and most of the uncrystallised substances, the whole of the refracted light is bent from its original direction at the same angle. In many others, as in most crystallised media, part of the refracted light follows one course, and another part of it a different one; the two portions acquiring at the same time different physical properties. In this case the refraction is said to be double, and the light becomes polarised. [POLARISATION.] A portion of the light falling on a body is reflected irregularly, and is scattered in all directions; it is this portion which renders bodies visible. All bodies on which light falls absorb a certain part of it; more or less in proportion to their opacity. In perfectly opaque bodies the absorption is total, and the light does not penetrate to a sensible depth under the surface. In others it penetrates farther; but even in the most transparent it is gradually extinguished. A depth of only seven feet of pure water is required to absorb one-half of the incident light. [REFLECTION.]

Solar light, refracted by a prism or other body, is separated into a multitude of rays of different colours, each of which afterwards proceeds in its course independently of all the others. These differently coloured rays possess different physical properties and different degrees of refrangibility. The investigation of

the laws of the dispersion of the coloured rays forms the subject of *chromatics*. One of the principal facts connected with it is, that the dispersion of the rays by different refracting substances is not proportioned to the refraction; the dispersive power of some substances being greater than that of others, while their refracting power is less. This fact led to the important discovery of the *achromatic telescope*. [ACHROMATISM; CHROMATICS.]

Light, on being regularly reflected or refracted, undergoes a modification termed *polarisation*, in virtue of which it presents, on encountering another medium, different phenomena of reflection and refraction from those presented by light which has not undergone such modification. [POLARISATION.]

The last property of light which we shall notice, as important towards forming a theory of its propagation, is that to which Dr. Young gave the name of *interference*. Under certain circumstances, the rays of light exercise a mutual influence on each other; increasing, diminishing, or modifying each other's effects according to certain laws. This mutual action of the rays on each other gives rise to a great number of the most beautiful and interesting phenomena of optics. These are described under the term INTERFERENCE.

Theories of Light.—Two different theories have been proposed regarding the nature and propagation of light. One of these consists in supposing it to be composed of particles of excessive minuteness, projected from the luminous body with a velocity equal to about 193,000 miles in a second. This hypothesis was adopted by Newton. The other hypothesis supposes light to be produced by the vibrations or undulations of an ethereal fluid of great elasticity, which pervades all space and penetrates all substances, and to which the luminous body gives an impulse which is propagated with inconceivable rapidity, in spherical superficies, by a sort of tremor or undulation, as sound is conveyed through the atmosphere, or a wave along the surface of water. The former theory has been totally abandoned, and we may therefore devote our attention exclusively to the latter, which is termed the *undulatory theory*. The principles of the undulatory theory are thus stated by Sir J. Herschel:—

1. 'That an excessively rare, subtle, and elastic medium, or *ether*, fills all space, and pervades all material bodies, occupying the intervals between their molecules; and, either by passing freely among them, or by its extreme rarity, offering no resistance to the motion of the earth, the planets, or comets, in their orbits, appreciable by the most delicate astronomical observations; and having inertia, but not gravity.

2. 'That the molecules of the ether are susceptible of being set in motion by the agitation of the particles of ponderable matter; and that when any one is thus set in motion it communicates a similar motion to those adjacent to it, and thus the motion is propagated farther and farther in all directions, according to the same mechanical laws which regulate the propagation of undulations in other elastic media, as air, water, or solids, according to their respective constitutions.

3. 'That in the interior of refracting media the ether exists in a state of less elasticity, compared with its density, than in vacuo (i.e. in space empty of all other matter); and that the more refractive the medium, the less, relatively speaking, is the elasticity of the ether in its interior.

4. 'That vibrations communicated to the ether in free space are propagated through refractive media by means of the ether in their interior, but with a velocity corresponding to its inferior degree of elasticity.

5. 'That when regular vibratory motions of a proper kind are propagated through the ether, and, passing through our eyes, reach and agitate the nerves of our retina, they produce in us the sensation of light, in a manner bearing a more or less close analogy to that in which the vibrations of the air affect our auditory nerves with that of sound.

6. 'That as, in the doctrine of sound, the frequency of the aërial pulses, or the number of excursions, to and fro, from the point of rest made by each molecule of the air, determines the pitch or note; so, in the theory of light, the frequency of the pulses, or number of impulses made on our nerves in a given time by the ethereal molecules next in contact with them, determines the *colour* of the light; and that as the absolute extent of the motion to and fro of the particles of air determines the *loudness* of the sound, so the *amplitude* or extent of the excursions of the ethereal molecules from their points of rest determines the brightness or intensity of the light.'

That the sensation of light is produced by the vibrations of an extremely rare and subtle fluid, is an idea that was maintained by Descartes, Hooke, and some others; but it is to Huygens that the honour solely belongs of having reduced the hypothesis to a definite shape, and rendered it available for the purposes of mechanical explanation. Owing to the great success of Newton in applying the corpuscular theory to his splendid discoveries, the speculations of Huygens were long neglected; indeed, the theory remained in the same state in which it was left by him till it was taken up by our countryman, the late Dr. Young. By a train of mechanical reasoning, which in point of ingenuity has seldom been equalled, Dr. Young was conducted by some very remarkable numerical relations among some apparently most dissimilar phenomena of optics, to the general laws of diffraction, and to the true principles of the colouration of crystallised substances. 'It is a theory,' says Herschel, 'which, if not founded in nature, is certainly one of the happiest fictions that the genius of man has yet invented to group together natural phenomena, as well as the most fortunate in the support it has received from whole classes of new pheno-

mena, which at their discovery seemed in irreconcilable opposition to it. It is, in fact, in all its applications and details, one succession of *felicities*; insomuch that we may almost be induced to say, if it be not true, it deserves to be so.' (*Ency. Metr.* 'Light,' § 595; Sir J. Herschel's *Treatise on Light*; Airy's *Mathematical Tracts*; Brewster's *Optics*; Young's *Lectures*; Biot, *Traité de Physique*; Pouillet, *Élémens de Physique*; Hunt's *Researches on Light.*)

An account of the principal *photographic processes* will be found under the term PHOTOGRAPHY.

LIGHT. In Painting, the medium by which objects are discerned. In a picture it means the part which is most illuminated. This may happen from *natural light*, as the sun or moon; or from *artificial light*, as a fire, candle, &c. The principal light is generally made to fall on the spot where the principal figures are placed, and generally near the centre of the picture. A reflected light is that which a body in shadow receives from a contiguous light object.

Light Ball. In Artillery, a cylindrical wrought-iron skeleton with hemispherical ends, covered with canvas, and filled with a composition of saltpetre, sulphur, resin, and oil, which, when ignited, burns for some time with a red flame. Light balls are employed in the defence of fortresses to discover the working parties and assaulting columns of the enemy, into whose trenches they are thrown.

Light Cavalry. Cavalry especially adapted by the lightness of their equipment, &c. for detached duties, skirmishing, &c. In our service cavalry is classed as *heavy*, including the 4th and 5th dragoon guards, and 1st and 2nd dragoons; *medium*, including the remaining regiments of dragoon guards and dragoons and the lancers; and *light*, including the hussars only.

Light Infantry. An honorary distinction by which eleven regiments of the line are called. They do not differ in any essential particular from the rest of the line.

Light Room. A small chamber adjoining, but isolated from, the powder magazine in a ship. It is separated from the latter by a glass partition, through which the light of the lanterns in the light room is thrown. The object is to prevent any combustible matter being taken into the magazine itself.

Lights, Artificial. Artificial light, in the practical acceptation of the term, always emanates from solid matter heated to whiteness, and in nearly all cases this solid matter is carbon. The most common sources of artificial light are coal-gas, oil, and candles, the flames of each of which are composed of jets of burning gas containing little particles of white-hot carbon. The first of the three is made at a distance, and conveyed to the burners by pipes; the other two are made on the spot, or the oil is decomposed into gas by the heat of the flame; and tallow or wax, being first melted by the heat, is then decomposed in a similar manner. Naphtha and other hydrocarbons resemble oil in containing carbon, and on being heated also give a jet of combustible gas containing floating particles of ignited carbon. Even the *electric light* proceeds from particles of white-hot carbon; the heat, however, being derived from the electric force instead of the chemical, as in the previously mentioned cases; by this means the carbon is made more intensely hot, and therefore gives out more light. The heat produced by the chemical action of the gas and air in common flames cannot easily be increased without too rapidly burning up the particles of carbon, that should yield light; under these circumstances, therefore, the flame will give less light. This occurs when excess of pure oxygen or even air is blown into the interior of such a flame; heat is then produced at the expense of light. But this heat can be utilised by introducing other solid matter into the flame, such as platinum wire, a lump of lime, even a piece of tobacco-pipe, or any similar solid that does not fuse or burn away. Such an arrangement forms the so-called *lime light*, frequently used for signalling and for exhibiting dissolving views.

Lights, Northern. [AURORA BOREALIS.]

Light-ship. A floating lighthouse. It is anchored firmly in positions where the bottom or the depth renders a fixed structure inapplicable.

Lighter. A strong vessel or barge for transporting goods or stores, chiefly on rivers or canals, or between vessels and a shore which they cannot approach on account of their draught.

Lighthouse. An establishment for the exhibition of a light or landmark to direct the mariner. The use of lights for such a purpose is of very high antiquity; but their early history is involved in much obscurity. In the ancient world there were lighthouses at Ostea, Ravenna, Puteoli, Caprea, Rhodes, on the Thracian Bosporus, &c.; but by far the most celebrated lighthouse in antiquity was that erected by Ptolemy Soter on the small island of Pharos, opposite to Alexandria—'nocturnis ignibus cursum navium regens.' (Pliny, lib. v. c. 31.) Its extraordinary height, which some authors have estimated at 500 feet and upwards, procured for it a place among the wonders of the world; and, according to Josephus, its 'beaming summit' could be seen at a distance of 300 stadia —about 42 British miles. It is said to have cost 800 talents; and its celebrity was such that Pharos rapidly became, and still continues to be in many countries, a generic name equivalent to *lighthouse*.

The most celebrated lighthouses of modern times are: the Tour de Corduan, at the entrance of the Gironde, in France; the Eddystone lighthouse, opposite to Plymouth Sound; and the lighthouse constructed on the Bell Rock, opposite to the Frith of Tay. The first of these was begun in 1584, and finished in 1611. It is 186½ feet (English) in height; and besides being of the highest importance to the sailor on so dangerous and frequented a coast,

it is at the same time a splendid architectural work. The Eddystone lighthouse, constructed by the celebrated engineer Smeaton, was completed in 1759. It is regarded as a masterpiece of its kind; and, as has been well remarked, it bids fair to be little less lasting than the rocks upon which it stands. The Bell Rock lighthouse was built by Mr. Stevenson on the model of the Eddystone. Numerous lighthouses, marking the most dangerous points, and the entrances to the principal harbours, are now erected in most civilised maritime countries. (The Trinity Board now regularly publish lists of all these lights.) But the coasts of no country are so well provided with lighthouses as those of the United Kingdom. For England, they are under the management of the Brethren of the Trinity House; for Ireland, under that of the Board for the Improvement of the Port of Dublin; and for Scotland, under that of the Commissioners of Northern Lighthouses meeting at Edinburgh.

The ancient mode of exhibiting lights as beacons to the mariner consisted in burning wood or coal in a chauffer on the top of a tower; and till the year 1807, the Eddystone light was nothing better than the feeble blaze of a few tallow candles, without any apparatus for concentrating the light or giving it any particular direction. Afterwards, however, Argand oil-lamps of great illuminating power were employed, and recently the magneto-electric light has been most successfully introduced into the South Foreland and Dungeness lighthouses; and it can scarcely be doubted that this intense light will soon be generally used in lighthouses.

As rays of light proceeding from a luminous body are equally dispersed over the surface of the sphere which has the luminous body for its centre, it is evident that without some means of giving the light a horizontal direction, the greater part of it must be wholly lost; for only those rays which are directed in the plane of the horizon, or at least which are depressed only a few degrees below it, can be seen from a ship at a distance. Hence the first object to be attained is to prevent the loss of light by throwing the whole of it forward in the plane of the horizon, in order that its intensity may be increased in the greatest possible degree. Now there are two principles on which this may be accomplished—reflection and refraction. The object is accordingly carried into effect by a catoptric or dioptric apparatus. Sometimes both principles are combined in the same apparatus.

Catoptric System.—The usual mode of applying the catoptric principle is by placing the source of light in the focus of a parabolic mirror. This mode of illumination appears to have been first carried into effect at the Corduan lighthouse above mentioned, under the direction of Borda, about the year 1780. A few years later reflecting mirrors were placed in some of the English lighthouses, under the direction of the Trinity House; and in 1786 the principle was adopted in the only two beacons then existing on the coast of Scotland—viz. the Isle of May in the Firth of Forth, and the Cumbrae Isle in the Clyde. Soon afterwards it was adopted generally in this country. Borda's reflector was formed of a sheet of copper plated with silver; those applied in Scotland were formed of small facets of mirror glass, placed in hollow parabolic moulds of plaster. The mirrors in general use in the British lighthouses at the present time are of copper coated with silver; the focal length is about three or four inches, and the diameter at the outer edge about twenty-one inches.

In order to produce a light of sufficient intensity, several parabolic mirrors, sometimes as many as eight, are placed on a frame, with their axes all parallel to each other, so that the light reflected by all of them is blended together in the same beam. To form a revolving light, the frame is attached to a horizontal axis, which is turned by means of clock machinery; and in this manner the different quarters of the horizon are successively illuminated. But as a rapid motion would be inconvenient, the frame has usually three or four sides, on each of which the same number of mirrors and lights is placed; so that the illumination is repeated three or four times in one revolution. To form a stationary light, a number of reflectors are placed round a circular frame, having their axes on the radii of the circle. This arrangement has one obvious defect; namely, that the illumination will not be equally intense at all azimuths, but strongest in the direction of the several axes, and feeblest in the direction of lines bisecting the several angles formed by each pair of contiguous axes. The defect is one which cannot be entirely remedied in a stationary light on the catoptric principle.

Dioptric System.—The introduction of lenses for the purpose of giving the light a horizontal direction is of recent date. A project for this purpose is indeed mentioned by Smeaton in his account of the Eddystone lighthouse, and about the end of the last century the method was tried in some lighthouses in the south of England; but from the imperfect figure of the lenses, and the absorption of the light caused by the great thickness of the glass, it did not succeed. But the art of grinding spherical lenses having been since brought to greater perfection, and a means of greatly diminishing the absorption, and also of constructing lenses of a much greater size, having been found in the use of polyzonal lenses (that is to say lenses formed of several pieces separately prepared and afterwards united) [POLYZONAL LENS], the system has been revived of late years, and in many instances carried successfully into execution. The merit of first applying such lenses to lighthouses belongs to the late Auguste Fresnel, of the Academy of Sciences of Paris. The annular lenses, constructed under the direction of Fresnel, for the principal lighthouses in France, are

plano-convex, having a focal distance of about three feet; and they are formed of crown glass as being less liable to *striæ* than flint glass.

The construction of a revolving dioptric apparatus of the first order is usually as follows: The revolving frame which carries the principal lenses has eight sides; and there are consequently eight large lenses, so arranged that their axes are all in the same horizontal plane, and meet in the common focus, where the lamp is placed. This frame, with its lenses, consequently forms an octagonal prism. For the purpose of preventing the loss of the rays which fall above and below the principal lenses, various methods are employed. One is to place above the first frame a second frame, whose sides form the frustum of an octagonal pyramid of 50° of inclination, in each of the sides of which is placed a lens having its focus in the flame of the lamp. The rays falling on these inclined lenses are refracted into directions parallel to the axis of the lens, and are then reflected into the horizontal direction by plain mirrors placed above the second frame. Another method is to place curved reflectors above the frame containing the principal lenses. But a third and still more elegant method, proposed by Fresnel, is to substitute for the upper lenses and mirrors a series of triangular prisms, having their axes arranged in horizontal planes, and so adjusted that the light falling on the face next the flame is thrown upon the back of the prism, where it suffers a total reflection; and a second refraction at the third side of the prism gives it the horizontal direction.

For fixed lights on the dioptric system, it is necessary to increase the number of the lenses, which in fact ought to be infinite, or to form a true cylinder, in order to produce an equal diffusion over every point of the horizon. In some of the French lighthouses the refracting apparatus consists of a polygonal belt of thirty-two lenses; but on establishing a dioptric apparatus at the Isle of May lighthouse, in 1836, Mr. Alan Stevenson proposed to form a true cylindric belt; and the task, though attended with much difficulty, was successfully executed at a glass-house in Newcastle.

A plan of the arrangement of the lenses for lighthouses, produced by Messrs. Chance at the Great Exhibition of 1862, combines the principles of Fresnel's fixed and revolving lights with an improved method of reflection; and does away with the use of metal reflectors.

The dioptric system is peculiarly adapted for fixed lights; and its advantages are these: 1. A light of equal intensity is distributed round every point of the horizon. 2. The consumption of oil is less for the same intensity of light, and consequently the expense of maintaining the light is less. 3. The trouble attending it is less, as there is only one lamp to trim, and the lenses are easily kept in order; whereas the reflecting surfaces require much care and attention. On the other hand, there is more risk from accident, for the accidental extinction of the lamp leaves the whole horizon in darkness; whereas in a system of reflectors the light would be extinguished over only a small portion of it.

One of the most important advances of recent times in lighthouse illumination is the introduction of the electric light, which, thanks to an admirable arrangement invented by Mr Holmes, may be made as tractable as the oil light, which doubtless it is destined in time to supersede. The more the light-source can be reduced in size, the more does the light-grasping arrangement of Fresnel come into play. The electric light being a point, can thus be wholly utilised, while its intensity is such that not only is it possible to produce a beam giving light enough to read by some ten or twenty miles off, but to *penetrate mists*, a quality which ought to be the sine quâ non of the light used in lighthouses. We regret we have not space to give a description of Mr. Holmes' arrangement; one will be found, however, in the *Reader*, vol. ii. p. 701. With regard to the comparative cost of the electric and oil lights, the French Director-General of Lighthouses has reported that, both as to first cost and cost of maintenance, the electric light is the cheaper of the two, the quantity of the manufactured article—light—produced being taken into account.

Method of distinguishing Sea Lights.—An object of great importance in the establishment of lighthouses is to vary the appearances of the different lights so that each may have some distinctive character by which it may be readily recognised, and the mariner be made aware of the part of the coast which he is approaching. Among the methods adopted for this purpose are the following: 1. The interposition of coloured shades before the lenses or refractors, so as to give a particular colour to the light: red is the only colour which can be used, as shades of any other colour are found to absorb too much light. 2. The time of revolution, or the length of the interval between the successive appearances of the light: this is the only mode of distinguishing lights adopted on the French coasts. 3. A *flashing light*; that is, a light of which the alternate flashes and eclipses succeed each other, so rapidly as to give the appearance of a succession of brilliant scintillations. 4. An *intermittent light*, which consists of a fixed light which is suddenly eclipsed, and after a stated interval as suddenly revealed: the appearance of this light is entirely different from that of any revolving light. 5. The exhibition of a double light, which admits of other distinctions; for the one light may be placed vertically above the other, or in the same horizontal plane; or one may be white and the other red. Sometimes three lights are necessary to indicate the entrances to harbours, &c.

The average annual expense of maintaining land light in Great Britain is about 500*l*., and that of a floating light about 1,200*l*.

(*Ency. Brit.* art. 'Sea Lights;' Smeaton

Narrative of the Eddystone Lighthouse, 1793; Stevenson's *Account of the Bell Rock Lighthouse*, 1824; Id. *British Pharos*, 1831; Brewster's *Treatise on Burning Instruments*, 1812; *The Lighthouses of the British Islands*, 1836; *Report of the Select Committee of the House of Commons on Lighthouses*, 1839; *Report to the Commissioners of the Northern Lighthouses*, by A. Stevenson, 1834; and *On the Inchkeith Dioptric Light*, 1836; Belidor, *Architecture Hydraulique*, tome iv.; Peclet, *Traité d'Éclairage*, Paris 1827; Fresnel, *Mémoire sur un Nouveau Système d'Éclairage des Phares*, 1822; A. Fresnel, *Description Sommaire des Phares et Fanaux allumés sur les Côtes de France*, 1837; Faraday 'On the Application of the Electric Light to Lighthouses,' *Proceedings of the Royal Institution*, vol. iii. p. 220; Frankland 'On Artificial Illumination,' *Proceedings of the Royal Institution*, vol. iv. p. 16.

Lightning. An electric phenomenon, produced by the passage of electricity between one cloud and another, or between a cloud and the earth.

The identity of lightning with electricity, though it had been previously suspected, was first directly demonstrated by the celebrated Dr. Franklin, in the year 1749, by the experiment of drawing sparks from the string of the electric kite. Since that time the science of electricity has been greatly advanced; nevertheless, the cause of some of the appearances connected with lightning is not well explained even at the present day.

The phenomenon of lightning is exhibited under two forms called respectively *forked lightning* and *sheet lightning*. The lightning is forked when the electric discharge occurs within a few miles of the earth's surface, and when it is directly seen by the observer. When, however, the discharge takes place below the horizon, or behind a dense cloud, only the scattered light reflected from the surfaces of the clouds illumined by the flash reaches the eye of the observer; the actual flash is not seen, but only the general illumination of a portion of the heavens. Such lightning is termed *sheet lightning*; and when the discharge takes place below the horizon or behind a very remote cloud, the distance is too great for the accompanying thunder to be heard. Sheet lightning may also sometimes be due to the electric discharges taking place at great elevations above the earth's surface. The more rarefied the air through which the electric spark passes, the less narrow and defined is its path. When the rarefaction is extreme, the discharge assumes the character of the aurora borealis; but in somewhat more dense regions of the atmosphere its appearance would resemble that of the peculiar kind of sheet lightning which is observed when the sky is free from clouds. Forked lightning is produced by the intense ignition of the particles of air lying in the path of this electric discharge, and is generally of a reddish tint, which is due to the pink light emitted by the nitrogen of the air when heated to incandescence. [ELECTRICITY.]

Lightning Conductor. The early researches of electricians demonstrated that the effects produced by the passage of lightning through different substances varied greatly according to the nature of the substance traversed. Thus, its passage through a good conductor, such as a bar of metal, of sufficient sectional area, was found to produce only a slight elevation of temperature in the metal, whilst on the other hand its transit through imperfect conductors, such as wood, stone, &c., was attended with great heat and destructive mechanical effects, by which such imperfect conductors were torn to pieces, and, if combustible, ignited. This knowledge of the effects of the disruptive electric discharge led to the invention and adoption of the lightning conductor, which consists of a rod of metal, or series of rods placed in metallic contact, and extending from the earth to some distance above the highest point of the building or ship which it is designed to protect. The upper extremity of the conductor should be pointed, in order to convert, as far as possible, the ordinary spark or globular discharge into the less instantaneous brush discharge, and every prominent angle of the roof of a building should be furnished with its own pointed rod carefully connected with the main rod which descends to the earth. The latter should have its lower extremity carried to some distance from the foundations of the building, and low enough to reach moist earth; or, better still, it may be connected with a gas or water main. According to Sir J. Snow Harris, a copper rod three-quarters of an inch in diameter is a sufficient and safe conductor for any stroke of lightning ever recorded. Usually a much smaller rod would doubtless suffice.

Lign Aloes (Lat. lignum aloës, *the wood of the aloe*). The fragrant wood of *Aloexylum Agallochum*.

Ligneous (Lat. lignum). In Entomology, a part is so called when it is composed of a hard inelastic substance like wood.

Lignin (Lat. lignum). This term has been applied to the pure woody fibre: it has also been called *cellulose*: its ultimate composition is represented by $C_6H_5O_5$, but a higher equivalent is better adapted to its combinations, and its most convenient formula is $C_{24}H_{20}O_{20}$; it belongs, therefore, to the class of compounds of carbon and water which includes starch, gum, sugar, and some other substances. The ordinary varieties of woody matter differ in colour and texture; but when freed from foreign matters, they leave a white translucent residue, insoluble in water, alcohol, and ether, and convertible, by sulphuric acid, into a substance having some of the characters of starch, and then into dextrine and sugar. Certain piths, linen, cotton, paper, and some other allied substances, are nearly pure cellulose. Weak acids and alkaline liquids, and a weak solution of chlorine, have scarcely any action on it, but they change,

combine with, or decompose it when concentrated, and some of these reactions are very important: when, for instance, clean linen or cotton rags are acted on by cold sulphuric acid, a magma is formed, which if immediately saturated by carbonate of baryta, or of lead, yields insoluble sulphates, together with soluble *sulpholignates*. These salts appear identical with those of the sulphoglucic or sulphosaccharic acid derived from the action of sulphuric acid on glucose. This magma is also blued by iodine. If it be much diluted and boiled, it yields dextrine, and ultimately glucose. By this action of sulphuric acid upon paper, a useful material now known as *vegetable parchment* is obtained. It is prepared by steeping thick unsized paper in a mixture of equal parts of sulphuric acid and water, at a temperature of sixty degrees, then washing it well in cold water and drying it. It is translucent, tough, and nearly impermeable to water, forming a useful substitute for common parchment or vellum. [PARCHMENT.] The action of nitric acid on lignine also gives rise to several curious and useful products which are elsewhere noticed. [GUN COTTON; PYROXYLINE.] The affinities of lignin for various other substances involve important considerations bearing upon the arts of dyeing and calico-printing, and upon the preservation of timber from decay and dry rot, which are also adverted to under separate articles. [DRY ROT; DYEING; TIMBER; WOOD.]

Ligniperdous (Lat. lignum, and perdo, *I destroy*). A term applied to insects which destroy wood.

Lignite. The varieties of brown coal which show distinct marks of having been formed of trunks of trees are conveniently separated from the rest under the name of *lignite.* On the Rhine, in the duchy of Nassau, are very large deposits of this kind, and in Styria near Grätz are others equally remarkable. The ash contained in lignite is generally very considerable, rarely less than 20 per cent. There is also much water, which can be removed by exposure, besides a large quantity of hygroscopic water. As all this must be got rid of before available heat is obtained for raising steam, lignite is not an economical fuel.

As distinguished from brown coal, the most remarkable lignites are those of the Rhine, and the best passages from the one mineral fuel to the other are seen in Styria.

All varieties of brown coal injure by exposure to weather; but lignite splits and tears, while brown coal of the best kinds falls to powder after a few months. These materials may both be kept somewhat longer if not exposed to the weather. Lignites are extensively used for fuel where nothing better can be had. [BROWN COAL.]

Lignone (Lat. lignum). A liquid which may be separated by distillation from commercial wood spirit. It has also been called *Xylite*.

Lignosulphuric Acid. An acid resulting from the action of sulphuric acid upon lignine. It is more properly termed *Sulpholignic acid.*

Lignum Vitæ (Lat. *wood of life*). The wood of *Guaiacum officinale*. [GUAIACUM.]

Ligula (Lat.). In Botany, a membranous appendage at the apex of the sheathing petiole of grasses, and analogous to the corona of some Silenaceous plants. The term *ligula* is also applied to certain bodies proceeding from the base, and alternate with the horns, of the organ called the *orbiculus* in Asclepiadaceous plants.

LIGULA. In Entomology, a name applied by Latreille to the lower lip of insects, or *labrum* of English entomologists.

Ligule (Lat. ligula). In Botany, the strap-like radiant florets of certain Composites. In a part of the order the ligulate florets are confined to the circumference; but in another group, the *Liguliflora*, they occupy the whole flower-head.

Liguliflore (Lat. ligula, and flos, *a flower*). That division of *Compositæ* in which the florets are all ligulate, and equivalent to the *Cichoraceæ* of Jussieu.

Ligure. The name of a stone mentioned as worn in the breastplate of the Jewish high priest (Exodus xxviii. 19). It was, probably, the same as the Jacinth or Hyacinth of the moderns.

Ligurite (so called after Liguria, the country where it is found). A variety of Sphene, of an apple-green colour, found in a talcose rock on the banks of the Stara in the Apennines. It resembles Chrysolite, but is considered superior to it as a gem, in colour, hardness, and transparency.

Ligustrin (Lat. lignum). A bitter principle found in the *Ligustrum vulgare*.

Ligustrum (Lat.). The genus of the Privet, a family of *Oleaceæ*, much grown in gardens, as ornamental evergreen or subevergreen shrubs. The Common Privet, *L. vulgare*, is much used for making hedges, and its purplish-black berries are said to be used amongst others for colouring inferior port wine.

Lilac. The *Syringa vulgaris* of botanists.

Lilac Stone or **Lilalite.** [LEPIDOLITE.]

Lilacine. A bitter crystallisable principle contained in the leaves of the *Syringa vulgaris*. It has also been termed *Syringine*.

Liliaceæ (Lat. lilium, *a lily*). A large natural order of Endogenous plants, typical of Lindley's Lilial alliance, with hexapetaloid hexandrous flowers, a superior ovary, and anthers which burst internally. They are familiarly known, in consequence of the Asparagus, the Lily, the Fritillary, the Harebell, the Star of Bethlehem, and many other common plants, forming a part of the order; which differs from *Melanthaceæ* in having a single style, not three styles, and in the anthers opening towards the style, not towards the petals. The species are extremely varied. Some, like the Dragon-trees, form a tall woody perennial stem, which emulates that of palm-trees; others are small bulbous plants, whose stem only lives a few weeks Almost all the order is sought after by cultivators of beautiful plants; and of the tulip and the hyacinth there are

innumerable varieties. Some Liliaceous plants secrete stimulating principles, which, in different degrees of concentration, give their activity to onions, garlic, chives, and similar garden productions, and medical value to squills.

Liliaceous. In Botany, a term invented by Link to denote a corolla the petals of which have their ungues gradually dilating into a limb, and standing side by side. It is rarely employed.

Lilium (Lat.; Gr. λείριον). A genus of *Liliaceæ* consisting of numerous beautiful flowers, which are great favourites in gardens. They are commonly called Lilies, and offer considerable variety of appearance. Several beautiful kinds are natives of Japan, the most glorious being *L. auratum*, with enormous white flowers spotted with rich red brown, and marked down each segment by a broad golden band. Some, as *L. eximium*, have long horizontal trumpet-shaped flowers; others, as the well-known White Lily, *L. candidum*, have the tube shorter, and the segments more rolled out; while others again, as *L. Martagon*, the Turk's Cap Lily, have the segments completely reflexed. In some countries the bulbous roots are eaten.

Lillite. A silicate of iron found at Przibram in Bohemia. It resembles Glauconite in appearance, and is probably a product of the decomposition of Iron Pyrites.

Lima (Lat. *a file*). A genus of Lamellibranchiate Bivalves, of the tribe *Ostraceæ*, characterised by the length of their shells as compared with those of the nearly allied genus *Pecten*, and their more regular oval form. The ridges of the shell are most of them relieved with scales. The *Limæ* swim with rapidity by means of their valves, but in a young state they secure themselves by means of a byssus.

Limacidæ. [Limax.]

Limacina (Lat. limax, *a slug*). A genus of Testaceous Pteropodous Molluscs, existing in considerable numbers in the northern seas, and forming, with the *Clio borealis* and other small marine animals, the food of the whalebone whale. The body terminates in a spirally convoluted tail, and is lodged in a very thin shell, formed by one whorl and a half, umbilicated on one side and flattened on the other. The animal uses its light shell as a boat, and its wing-like fins as oars, and thus navigates in countless fleets the surface of the tranquil deep.

Limaçon (Fr.). This name appears to have been given by Pascal to a certain curve of the fourth order and sixth class, whose form somewhat resembles a shell. It is generated from a circle by adding to and subtracting from all radii vectores through a point of its circumference a given constant length. Its polar equation, therefore, if a denote the radius of the circle and $2b$ the length added and deducted, is

$$r = 2(a \cos\theta + b).$$

In rectangular coordinates, its equation may be written in the form

$$[(x-a)^2 + y^2 - a^2 - 2b^2]^2 = 4b^2\left(b + 2\frac{a}{b}x\right),$$

whence we learn that the curve has a double point at the origin, two cusps at the circular points at infinity, a double tangent parallel to the ordinate axis at the distance $-\frac{b^2}{2a}$ from the origin, and two points of inflexion. It belongs also to the class of Cartesian ovals, and includes the cardioid as a particular case corresponding to $b = a$. Just as the latter curve can be generated as an epicycloid, so the *limaçon* may be generated as an epitrochoid, the rolling circle being taken equal to the fixed one.

Limax (Lat. *a slug*). The name of a genus of the Linnæan *Vermes Mollusca*, of which the common slug is the type. The genus enters into the class *Gasteropoda* and order *Pulmonaria* of the system of Cuvier; and is now raised to the rank of a family (*Limacidæ*), which includes *Limax* proper; *Arion*, Fér.; *Incilaria*, Benson; *Testacella*, Lam.; *Parmacella*, Cuv. &c. Each of these genera has a small scutiform rudimental shell developed in the substance of the mantle, and protecting the heart. The orifice of respiration in the true slugs (*Limax*, Cuv.) is on the right side, and not so far forward as in *Arion*. The rudimental shell is marked with fine and concentric striæ, and is calcified internally. The species of this genus are the pests of gardens and cultivated grounds. Young plants may be protected from slugs by having a coarse horsehair rope coiled round their stems, or by being plentifully sprinkled with soot; or they may be watered morning and evening with strong and fresh lime water.

Limb. In Astronomy, the border or outermost edge of the sun, moon, or of a planet. Also the graduated edge of a circle, or other astronomical instrument.

Limb or **Limbus** (Lat. *a border*). In Botany, a term applied to petals, to denote that portion which is supported by the unguis or claw; it is the same organ in a petal as the lamina in a leaf, and is what constitutes the broad thin coloured part which renders many flowers so beautiful.

Limbelite. An altered form of Chrysolite, occurring in small wax or honey yellow masses, in the basalt of Limbourg.

Limber (of uncertain derivation; possibly connected with limp, Swiss lampen, *to hang loose*: Wedgwood). In Artillery, a two-wheeled carriage, carrying ammunition boxes, to which the trail of the gun carriage is attached, when the latter has to be moved. It thus forms with the gun carriage a four-wheeled carriage. To *limber up* is to attach the gun to the limber.

Limber Strakes. The planking of a ship's internal skin, above the floor timbers, and next, horizontally, to the limbers. They are among the thickest of the planks used.

Limbers. In Shipbuilding, the main drains of the vessel. They are gutters running along each side of the keelson, receiving the hose of the pumps, and all the internal drainage of the

vessel. They are emptied from time to time by the pumps.

Limbo (Lat. limbus, *a hem or edge*). A region supposed by some of the schoolmen to lie on the edge or neighbourhood of hell. This served as a receptacle for the souls of just men, not admitted into purgatory or heaven. Such were, according to some Christian writers, the patriarchs and other pious ancients who died before the birth of Christ: hence the limbo was called *limbus patrum*. These, it was believed, would be liberated at Christ's second coming, and admitted to the privileges of the blessed in heaven. This latter idea is probably an adorned representation of the remarkable passage in St. Peter's Epistle (1 iii. 19), where he says that Christ preached to the spirits in prison; and being held by certain of the later fathers, seems to have given some influence to the growing opinion in favour of a purgatory. Dante has fixed his limbo, in which the distinguished spirits of antiquity are confined, as the outermost of the circle of his hell. The use which Milton has made of the same superstitious belief is well known. (*Paradise Lost*, book iii.) The analogous term, *limbus puerorum*, was applied to the abode of children dying unbaptised before the commission of mortal sin. It is described as a neutral state, without actual happiness or torment. Some of the fathers held, however, a less merciful doctrine. In one of his sermons against Pelagius, Augustine declared that such infants descended into everlasting fire, while Fulgentius maintained that even children dying before birth must be punished by the eternal torture of undying fire. (Lecky, *Hist. of Rationalism in Europe* i. 397.)

Lime (Ger. leim, *glue*). This very useful earth is obtained by exposing chalk and other kinds of limestone, or carbonates of lime, to a red heat—an operation generally conducted in kilns constructed for the purpose; the carbonic acid is thus expelled, and lime, more or less pure, according to the original quality of the limestone, remains. In this state it is usually called *quicklime*. Its specific gravity is about 3. When sprinkled with water it becomes very hot, and crumbles down into a dry powder, called *slaked lime*, or *hydrate of lime*. When exposed for some weeks to the air, it also falls into powder, in consequence of the absorption of moisture and of a portion of carbonic acid from the atmosphere; so that, in this case, part of the lime gradually reverts to the state of carbonate, and loses its causticity.

Pure lime may be obtained by heating powdered Carrara marble to whiteness in an open crucible. It is white, very infusible, but promotes the fusion of some other earths and oxides, and is therefore used as a *flux* in several metallurgic processes. It is highly luminous when intensely heated, as for instance by the oxy-hydrogen blowpipe. [DRUMMOND'S LIGHT.]

Lime is soluble in about 700 parts of water, and is somewhat more soluble in cold than in hot water. But, weak as this solution is, its action is powerfully alkaline upon vegetable colours, and has an acrid taste. It absorbs carbonic acid by exposure to air; and as *carbonate of lime* is insoluble in water, it becomes milky in consequence; so that lime-water is a useful test of the presence of carbonic acid.

The nature of lime was first demonstrated by Davy in 1807: he showed that, like the other alkalies, it was a metallic oxide. The metallic base of lime has been termed *calcium*: its equivalent is 20, and lime, being a compound of one atom of calcium and one of oxygen (CaO), is represented by the equivalent 28; and hydrate of lime by 28 lime + 9 water = 37.

The *salts of lime* are generally obtained by dissolving carbonate of lime in the respective acids: several of them exist native. *Sulphate of lime* (CaO,SO_3), selenite, or gypsum, is an abundant natural product, and may be formed artificially by adding sulphuric acid, or the soluble sulphates, to solutions of the salts of lime. It consists of 28 lime + 40 sulphuric acid, and its crystals include two atoms = 18 of water. When these crystallised sulphates of lime are heated, they part with their water and fall into a white powder, called *plaster of Paris*; when this is mixed with water it again combines with it, and concretes into a white mass; hence its use for casts, busts, &c. Sulphate of lime is often contained in spring water, which is thus rendered *hard* and unfit for washing. These waters become turbid upon the addition of a spirituous solution of soap. *Phosphate of lime* ($3CaO,PO_5$) is found *native*, constituting the mineral called *apatite*. The *earth of bones* is also chiefly a similar phosphate of lime. *Oxalate of lime* is very insoluble, and is precipitated whenever oxalic acid or a solution of an oxalate is added to solutions containing lime; hence it is that oxalate of ammonia is so valuable a test of the presence of lime, and is frequently used for the purpose of separating lime in analysis. When oxalate of lime is well dried, at 500°, it is anhydrous, and consists of 28 lime + 36 oxalic acid = 64 oxalate of lime. This substance is occasionally found in the human urine, and sometimes forms calculi: these are often of a reddish brown colour and a rough exterior, whence they have been termed *mulberry calculi*. When hydrate of lime is exposed to chlorine, the gas is absorbed, and a *chloride of lime* is obtained. This article is manufactured upon an extensive scale, under the name of *bleaching powder*, and consists of about 33 per cent. of chlorine and 67 of hydrate of lime. It evolves chlorine when acted upon by acids; and gives it out very slowly when exposed to air, in consequence of the absorption of carbonic acid. It is a most useful disinfecting material, and when dissolved in water forms *bleaching liquid*. *Carbonate of lime* (CaO,CO_2) is thrown down when alkaline carbonates are added to solutions of the salts of lime. It is a most abundant natural product, and is found pure in the varieties of calcareous spar and statuary marble. Chalk and several varieties of limestone are also nearly pure carbonates of lime. It is easily

distinguished from other minerals by effervescing in dilute acids and by yielding quicklime when a fragment is heated before the blowpipe. It is constituted of 28 lime + 22 carbonic acid: the equivalent, therefore, of carbonate of lime is 50. [LIMESTONE.]

The uses of lime are very numerous. Its most important application is in the manufacture of mortar and other cements used in building. It is also very extensively used as a manure to fertilise land.

LIME (so called from the glutinous juice of the young shoots: the word is the same as Ger. leim, Lat. limus, Eng. *slime* and *loam*). The name of the Linden-tree, *Tilia europæa*, which, however, is by some authors said to be more correctly Line-tree, from its bark or bast being used to make cordage. The name is also applied to certain fruits of the *Citrus* family, related to lemons and citrons. The varieties of *Citrus Limetta* are called sweet limes; and some varieties of the lemon, *C. Limonium*, are also popularly called limes. The fruit, like that of the lemon, is used for its acid juice.

Lime Burning. Although all carbonates of lime may, by burning, be brought to the state of quicklime, chalk and *compact* limestone are alone used for this purpose in the large way. The limekiln at present almost universally employed in this country is a cup-shaped concavity, in a solid mass of masonry, open at top and terminated at bottom by a grate, immediately above which is an iron door. This simple furnace is first charged with fuel (either wood, or coal and cinders), upon which is afterwards laid a stratum about a foot thick of chalk or limestone, broken into pieces not larger than the fist; to this succeeds a charge of fuel, and so on alternately, keeping the kiln always full. The pieces of limestone descend towards the bottom of the kiln in proportion as the fuel is consumed, being in the meantime kept at a pretty full red heat. At this temperature, the water and carbonic acid are driven off; and by the time the limestone arrives at the bottom of the kiln, which happens in about forty-eight hours, it is rendered perfectly caustic. The door above the grate is then opened, and the lime below the next descending stratum of fuel is raked out; the remaining contents of the furnace sink down, and a fresh charge is laid on the top. The compact limestone, after having undergone this process, though lighter and more porous than before, still retains its figure unaltered; hence it is readily separable from the ashes of the fuel, and is sufficiently hard to be carried from place to place without falling to pieces. The management of the kiln as to temperature varies with the nature of the limestone, which if silicious and overheated is apt to be partially vitrified; such lime slakes imperfectly, leaving a *core*, and is said to be *dead-burnt*.

Attempts have been made to burn lime, or, in other words, to expel the carbonic acid from limestone, in close vessels, but the carbonic acid cannot be so driven off.

Lime Light. [DRUMMOND'S LIGHT.]

Limestone. Stone consisting chiefly of uncrystallised carbonate of lime. Perfectly crystallised carbonate of lime is *calc spar* or *Iceland spar*. Imperfectly crystallised carbonate of lime with a fine grain, or with the texture of sugar, is called MARBLE [which see]. Carbonates of lime and magnesia are described as MAGNESIAN LIMESTONES.

Compact limestone is sometimes white and nearly pure, sometimes coloured with iron or other metallic oxides, and often mixed irregularly with clay and sand. It passes by insensible gradations into impure limestone, marlstone, calcareous clay, and marl.

Limestones of all kinds are found in rocks of all geological ages; but it is generally fancied that the more crystalline varieties occur with the more ancient or the more distinctly metamorphic rocks. Thus in England the carboniferous limestones pass into marble. In the Alps, however, the oolitic rocks, and in the Carpathians cretaceous rocks, assume this form, and not unfrequently even tertiary rocks are altogether crystalline. On the other hand, the Silurian limestones are mere mudstones, and quite uncrystalline, so that there is no real law on the subject.

Whenever limestones are not distinctly metamorphic, they bear traces of organic structure. This is so much the case as to justify the assumption by geologists that all limestone is the result of organic action at some period or other. The indication of life is of various kinds, often microscopic. Corals, shells, and even bones make up in some cases the entire mass of large deposits. In other cases the limestone consists of minute particles of such bodies so cemented and combined into a solid, that it is scarcely possible without minute investigation to discover the secret. Shelly limestones of the oolitic period, such as are common at Bath and Portland Island, afford good examples of the first, and chalk of the latter condition.

Limestones are extremely useful, and therefore it is very important to discover them in every country. Of themselves, when in sufficient abundance, they generally make excellent building material. When not so used, they may be burnt to produce lime, either to work up into mortar, or employed for agricultural purposes. Forming part of a soil, the disintegrated fragments that are loosened from the rock below often mix with clay and produce useful soils during their slow decomposition. Worked up into the soil in a powdery state, they form marls and other useful admixtures.

In England the limestones are of four kinds: compact limestones, passing into marble of the carboniferous and Devonian period; oolitic limestones; mudstones, or impure clayey limestones, and marlstones, from both of which hydraulic cement is made; and chalk. The Silurian limestones are, for the most part, mudstones; the lias yields marlstone; and the rest belong to the middle and upper part of the

secondary period. There are in England no limestones belonging to the tertiary period, but they are abundant and excellent in the rocks of this date in the Paris Basin.

There is no necessary resemblance between the contemporaneous limestones of different countries; for of all deposits, limestones are those which are least persistent as mineral types of geological periods. Thus Silurian limestones in the north-east and north of Europe are semi-crystalline; the oolitic, or, as they are there called, Jurassic, limestones of the Alps are compact; the cretaceous limestones of the Caucasus are marble; and the tertiary rocks of the Paris Basin are calcareous, and afford excellent building material.

There are many local names for varieties of limestone. Some are called RAG STONE, others are FLAG STONES. CHALK is a well-known variety, and hard chalk is called CLUNCH. We have STONESFIELD SLATE, CEMENT STONE, SEPTARIA, KENTISH RAG, FOREST MARBLE, SUSSEX MARBLE, KELLOWAYS ROCK, MARLSTONE, and many others, all more or less distinct. Most of these will be found briefly described under their respective heads.

Limit (Lat. limes, limitis). In Mathematics, a given or determinate quantity to which some other variable quantity continually approaches in value, but never reaches. Thus, if we suppose a polygon to be inscribed in a circle, by increasing the number of sides of the polygon its area is increased. But the area can never exceed that of the circle within which the polygon is inscribed; and it is only when the number of its sides is conceived to be infinitely great that its area becomes equal to that of the circle. The circle is thus said to be the limit of the areas of the inscribed polygon.

Again, the limit to which $(1+\frac{m}{n})^{nx}$ approaches as n is continually increased is e^{mx}, where e denotes the number 2·7182818 . . . known as the base of Napierian or natural logarithms. This important theorem is expressed thus: lim. $(1+\frac{m}{n})^{nx}=e^{mx}$.

One of the most satisfactory ways of establishing the principles of the differential calculus is by the consideration of *limits*. This was done by D'Alembert, though his *method of limits* coincides practically with that of *prime and ultimate ratios* employed by Newton in his *Principia*.

The *limits* of a definite integral are the values of the independent variable which correspond to the extreme terms of the series whose sum that integral represents. [DEFINITE INTEGRAL.]

Limitation. In Law, this term is generally used to express the time allowed by statutes for the commencement of litigation after the act complained of. The period beyond which personal actions of trespass, or debt on simple contract, cannot be brought, is defined by the stats. 21 Jas. I. c. 16 and 19 & 20 Vict. c. 97. They must be commenced within six years after the cause of action; with the exception of actions of assault, menace, and imprisonment, which are limited to four. But a right of action may be revived by an express acknowledgment on the part of the debtor.

Penal actions for forfeitures made by statute must be sued in general, according to the terms of the statutes, within two years or one year.

By the statute 3 & 4 Wm. IV. c. 27, all process for the recovery of land by entry and distress, or by action, whether real or mixed, must be commenced within twenty years after the right of action accrued. Persons under the disabilities of infancy, coverture, idiotcy, lunacy, unsoundness of mind, or absence beyond seas, are allowed ten years after the termination of their disability; so that forty years be in all cases the extreme limit. This statute extends both to suits in equity and actions at law. No advowson can be recovered after one hundred years. Money charged upon land, and legacies, are deemed satisfied at the end of twenty years unless there have been some receipt or acknowledgment; and by stat. 23 & 24 Vict. c. 38 the same rule is extended to claims by the next of kin of intestates. Arrears of rent, or interest of money charged on land, cannot be recovered after six years, unless secured by bond or covenant, when by statute 3 & 4 Wm. IV. c. 42 actions may be brought at any time within twenty years after the cause of action has accrued. The various limitations in proceedings arising out of bankruptcies are defined by the bankrupt Acts. These are among the principal instances of legal limitation; but there are many more: a tabular arrangement of all will be found in Wharton's *Law Lexicon* (1860).

The statutes of limitation apply to equitable remedies directly, and by the plain import of the statutes, where the equitable remedy is sought (as it may be in some cases) for a right enforceable at law; and they have been adopted by analogy in those cases where a purely equitable right is the counterpart of a legal one, as the right to mesne profits in respect of an equitable ownership, or a debt payable in equity but not in law. Where there is not this strict correspondence between the equitable and legal claims, the rule prevails that twenty years' adverse possession, which is in law a bar to the possessory action for land, shall be a bar to all equitable claim, whether the adverse right be merely equitable also or equitable and legal; such period of limitation being, as at law, capable of extension from infancy, absence, or disability. But time is not a bar to the claim of cestui que trust against his trustee, where the trusteeship was in the origin direct and express, and not coupled with any beneficial interest, as it is in the case of a mortgage; nor does a purchaser, with notice from a trustee, stand in a better situation in respect to time than the trustee himself.

Limnæus (Gr. λιμναῖος, from λίμνη, *a pool*). A genus of fresh-water snails; so named from their general location in ponds, ditches, and other receptacles of stagnant water. Many species of this genus are natives of Britain.

Limning (Lat. lūmen, *light*). Illuminating. The art of painting in water colours; in which sense it is used to distinguish it from painting in oil colours. The term was originally applied to the decoration or illumination of MSS.

Limonin. A bitter crystalline matter found in lemon and orange pips.

Limonite (Gr. λειμών, *a meadow*). In Mineralogy, Brown Iron-ore. It is a hydrated peroxide of iron.

Limosa (Lat. from limus, *mud*). A genus of wading birds, belonging to the tribe *Longirostres*; and characterised by a straight beak, longer than that of the snipes (*Scolopax*), and sometimes slightly bent at the extremity; the nasal groove extends close to the tip, which is blunt and somewhat depressed; there is no third groove or punctation on its surface. The external toes are palmated at the base: they are longer and slenderer than in the snipes. The species of *Limosa* which, with us, are vernacularly termed Godwits, frequent salt marshes and the seashore.

Limosis (Gr. λίμος, *hunger*). A genus of diseases distinguished by excessive or defective appetite.

Limpets. [PATELLOIDS.]

Limulus (Lat. limus). A genus of gigantic Entomostracous Crustacea, in which the haunches of the first six pairs of feet are beset with small spines, and are so closely approximated about the mouth as to serve the office of jaws. The œsophagus, instead of proceeding backwards, is continued forwards for a short distance into the anterior part of the shield before it enters the stomach; this cavity is lined with a thick rugous cuticle, and terminates in the intestine by a long muscular and valvular projection. The heart is elongated, vasiform, and muscular; the branchiæ are supported on a series of closely packed broad plates beneath the post-abdomen. The total number of feet is twenty-two: the first ten, with the exception of the two anterior ones in the males of some species, are terminated by a didactyle forceps, and are inserted, with the two following pairs, beneath a large semilunar shield. The species of this genus are found on the shores of the North American and Asiatic continents: they are commonly known by the names of king crabs, horse-shoe or molluscа crabs. The tail is long, straight, sharp-pointed, and of sufficient strength and size to be used as a spear-head or arrow-point by savages.

Linaceæ (Linum, one of the genera). A small natural order of herbaceous Exogens, principally inhabiting Europe and the North of Africa; allied, according to De Candolle, to *Silenaceæ*, *Malvaceæ*, and *Geraniaceæ*. The want of a gynobasic structure, the imbricate calyx, the regular flowers, and the small quantity of albumen in the seeds, rather point out an affinity with *Cistaceæ* and its allies. Their chief characters are the tenacity of their fibre, the mucilage of their seeds, and the beauty of their flowers. Common flax or lin (whence linseed) is the most important plant of the order.

Linarite or **Cupreous Anglesite.** Native cupreous sulphate of lead often forming twin crystals of a deep azure-blue colour at Linares in Spain; also in Cumberland, at Leadhills in Lanarkshire, &c.

Lincolnite. A variety of Heulandite from Durfield in Massachusetts.

Linctus (Lat. from lingo, *I lick*). A medicinal preparation of the consistence of thick syrup, or honey, which requires to be licked off the spoon.

Lindackerite. A hydrated arsenite of copper with sulphate of nickel, of a verdigris or apple green colour, occurring at Joachimstahl in Bohemia. Named after the Austrian chemist, Lindacker.

Linden-tree. The Lime-tree, *Tilia europæa*.

Lindsayite or **Linseite.** A hydrated variety of Amphodelite from Finland; the result, probably, of partial alteration.

Line (Fr. ligne, Lat. linea). In Fortification, any extended defence; as a ditch with its parapet, a row of gabions, &c.

LINE. In Geography and Navigation, is used for the equator: as equinoctial *line*.

LINE. In Geometry, a magnitude having only one dimension. Euclid defines it to be 'that which has length without breadth.'

LINE. In Military affairs, a term used to distinguish what may be called the regular cavalry and infantry of Great Britain from other military corps or establishments. All numbered cavalry and infantry regiments except the life guards, foot guards, and dragoon guards, belong to the *line*.

Troops are said to be *in line* when their formation is of considerable frontage but little depth, as opposed to *column*. [COLUMN.]

Line of Battle. The line formed by the ships of the fleet when ranged ahead and astern of each other, at equal distances, and close-hauled or nearly so. It could be formed accordingly upon either tack. The line was composed of ships of not less than two decks, thence called *line-of-battle ships*. The invention of steam, and the introduction of long-range guns, with iron-sided ships, and their adaptation as rams, render it probable that in future the line of battle will give way to rapid evolutions by which the vessels will seek to outmanœuvre each other.

Line of Bearing. The line of bearing is formed by the ships of the fleet when ranged on a line six points from the wind, at equal distances, and with their heads in any direction whatever. The line is called by the name of that tack upon which if the ships were to haul to the wind together they would form the line ahead. For example; suppose the wind N., and the ships in a line W.N.W. and E.S.E. of each other; this is the *starboard* line of bearing, whether the ships are going free, or close-hauled upon the *port tack*.

Line of Curvature. [CURVATURE.]

Line of Defence. In Fortification, the line of the top of the scarp of any work re-

ceiving flank defence; or that line together with its prolongation to the flanking work.

Line of Dip. In Geology, the strata which form the crust of the globe are rarely horizontal, but incline to some point of the horizon, and rise to the opposite point; a line drawn through these points is called the line of their *dip*.

Line of Fire. In Gunnery, the line formed by the axis of the piece produced. Whenever the gun is not laid point blank, the line of fire forms an angle with the line of sight. This is called the *angle of elevation*.

Line, Geodesic. [GEODESIC LINE.]

Line at Infinity. [INFINITY.]

Line of Least Resistance. In Military Mining, the line drawn from the centre of the charge perpendicularly to the surface.

Line of Metal. In Gunnery, a visual line, joining the notches cut on the highest point of the breech and muzzle when the trunnions are perfectly horizontal.

Line of Metal Elevation. In Gunnery, the elevation due to the conical form of a gun; when the gun is laid on an object by the line of metal.

Line of Nodes. In Astronomy. [NODES.]

Line of Operations. In Strategy, the line of communication from the original source of supplies or base of operations to the army.

Line of Sight. In Gunnery, the line passing through the two sights of a gun, at any elevation, and the object.

Line of Spherical Curvature. [CURVATURE, SPHERICAL.]

Lines. In Shipbuilding, the delineation of the form of an intended vessel supplied by the naval architect to the shipbuilder for his guidance in his work. They are the boundaries, on the ship's exterior, of vertical and horizontal planes passing through various parts. [NAVAL ARCHITECTURE.]

Lines of Circumvallation and Contravallation. [CIRCUMVALLATION; CONTRAVALLATION.]

Lineal Consanguinity. In Jurisprudence. [CONSANGUINITY.]

Linear (Lat. linearis, from linea). In Mathematics, a term, of geometrical origin, applied in various (more or less technical) ways, but usually to magnitudes of one dimension or to functions of the first degree in a certain set of variables or facients. Thus a linear transformation is one where each variable is replaced by a function of the first degree in the new variables, and so in other cases. An expression involving two sets of variables is said to be *lineo-linear* when it is of the first degree, whether considered as a function of one set or of the other. [TANTIPARTITE FUNCTION.]

Linear Differential Equation. An equation which is of the first degree when the expression equated to zero is regarded as a function of the dependent variables and its differential coefficients. It should be noticed that according to this definition a differential equation of the first degree is not necessarily linear. [DIFFERENTIAL EQUATION.] The general form of the latter is—

$$\frac{d^n y}{dx^n} + X_1 \frac{d^{n-1} y}{dx^{n-1}} + X_2 \frac{d^{n-2} y}{dx^{n-2}}$$

$$+ \dots + X_{n-1} \frac{dy}{dx} + X_n y = X,$$

wherein the coefficients X_1, X_2 &c. . . , and the right-hand member X, are either constants or functions of the independent variable x. If the coefficients involved the dependent as well as the independent variable, the equation would be simply referred to as of the n^{th} order and first degree. The complete solution of a linear differential equation of the n^{th} order involving n arbitrary constants, can be readily deduced from any particular solution, provided the complete solution were known of the equation possessing the same coefficients X_1, X_2, &c., but no second member, or rather if $X=0$. In fact, if

$$y = F(x, c_1, c_2 \dots c_n)$$

be the complete solution in the latter case, and $y=f(x)$ the particular solution, the complete solution of the above equation would be

$$y = f(x) + F(x, c, c_1 \dots c_n).$$

When the coefficients of a linear differential equation are all constants, the calculus of operations enables us to express its solution in a very elegant form. In fact, separating the symbols of operation and quantity, such an equation may be written in the form

$$F\left(\frac{d}{dx}\right) y = X,$$

where F denotes a rational integral function of the n^{th} order. If, for the sake of an illustration, we suppose the equation $F(\xi)=o$ to have n unequal roots $a_1, a_2 \dots a_n$, and $\frac{1}{F(\xi)}$, when resolved into partial fractions, to be equal to

$$\frac{A_1}{\xi - a_1} + \frac{A_2}{\xi - a_2} + \dots \frac{A_n}{\xi - a_n},$$

then the solution of the above equation may be exhibited thus:

$$y = \left[F\left(\frac{d}{dx}\right)\right]^{-1} X = \sum_1 A_1 \left(\frac{d}{dx} - a_1\right)^{-1} X.$$

Now by the definition of inverse symbols of operation, we have, on representing

$$\left(\frac{d}{dx} - a_1\right)^{-1} X \text{ by } u,$$

$$\left(\frac{d}{dx} - a_1\right) u \ \ \frac{du}{dx} - a_1 u = X,$$

a linear differential equation of the first order whose complete solution is well known to be

$$u = e^{a_1 x} \left\{ \int e^{-a_1 x} X\, dx + C_1 \right\};$$

so that the complete solution of the linear differential equation is

$$y = \sum_1 A_1 e^{a_1 x} \left\{ \int e^{-a_1 x} X\, dx + C_1 \right\}.$$

where C_i is an arbitrary constant, and the summation $\sum_i$ extends to the values $i=1, 2 \ldots n$. For the modifications to be introduced when $F(\xi)=o$ has equal, real or imaginary, roots, we must refer the reader to Prof. Boole's excellent treatise on Differential Equations (Cambridge 1859) or to his original memoir in the *Phil. Trans.* 1844.

M. Lobatto, in his *Théorie des Caracteristiques*, Amsterdam 1837, appears to have been the first to exhibit the solution of a linear differential equation with constant coefficients in the above form. For the full developement of the symbolical method, however, we are chiefly indebted to Prof. Boole.

Linear Perspective. This name is applied to that branch of perspective which regards only the positions, magnitudes, and forms of the objects delineated; as distinguished from *aërial perspective*, in which the variations of the light, colour, and shade of objects, according to their different distances and the quantity of light that falls on them, are also considered and represented.

Linear Transformations. In Algebra, transformations whereby each one of a set of variables is replaced by linear functions of a new and equally numerous set. Geometrically, this is equivalent to the transformation of coordinate axes. Thus if $x_1, x_2, \ldots x_n$ denote the original system of variables, and $\xi_1, \xi_2, \ldots \xi_n$ the new system, the transformations will be linear if the two sets are connected by relations of the form—

$$
\begin{aligned}
x_1 &= a_{11}\xi_1 + a_{12}\xi_2 + \ldots a_{1n}\xi_n,\\
x_2 &= a_{21}\xi_1 + a_{22}\xi_2 + \ldots a_{2n}\xi_n,\\
&\qquad\qquad \ldots\ldots\\
x_n &= a_{n1}\xi_1 + a_{n2}\xi_2 + \ldots a_{nn}\xi_n.
\end{aligned}
$$

The determinant formed from the coefficients,

$$
D = \begin{vmatrix} & \ldots & a_{1n}, \\ a_{21}, a_{12}, & \ldots & a_{2n} \\ & \ldots & \\ a_{n1}, a_{n,2} & \ldots & a_{nn} \end{vmatrix}
$$

is called the *modulus of transformation*, and when D is equal to unity the transformations are said to be *unimodular*. The theory of linear transformations plays a most important part in modern algebra. [INVARIANTS; COVARIANTS.]

By solving the above system of equations, we obtain the reciprocal transformations

$$
\begin{aligned}
D \,.\, \xi_1 &= A_{11}x_1 + A_{21}x_2 + \ldots + A_{n1}x_n,\\
D \,.\, \xi_1 &= A_{12}x_1 + B_{22}x_2 + \ldots + A_{n2}x_n,\\
&\ldots\ldots\ldots\ldots\\
D \,.\, \xi_n &= A_{1n}x_1 + A_{2n}x_2 + \ldots + A_{nn}x_n;
\end{aligned}
$$

when each coefficient A_{hi} is a *first minor* of the modulus of transformation; obtained, in fact, from the determinant D by omitting the i^{th} column and h^{th} row, and affixing the sign $(-1)^{(h-1)(i-1)}$ to the resulting determinant of the $(n-1)^{th}$ order. The modulus of the reciprocal transformations is easily shown to be equal to D^{n-1}, so that the latter are unimodular when the original ones are unimodular.

Linen. A species of cloth woven with the fibres of the flax plant (*Linum usitatissimum*). The origin of the manufacture of linen is lost in its antiquity. In the time of Herodotus linen was an article of export from Egypt, where it had been used from time immemorial; but it is evident that in ancient times its use was limited to the noble and the rich. In modern times linen constitutes a staple manufacture in almost all European countries; but more especially in Germany, Russia, Switzerland, Flanders, England, Scotland, and Ireland. In England it has been prosecuted for a very long period; but until of late years its progress has been inconsiderable, compared at least with that made in other branches of manufacture. This seems to be partly owing to the attempts to bolster up and encourage the manufacture in Ireland, partly to the restrictions which were for a lengthened period laid on the importation of foreign flax and hemp, and partly to the rapid growth of the cotton manufacture—fabrics of cotton having to a considerable extent superseded those of linen. It is only within the present century that any machinery has been used in the production of linen cloth. The first mills for the spinning of flax were constructed at Darlington; but the principal seats of the manufacture now are—in England, Leeds and its immediate vicinity, and in Lancashire, Dorset, Durham, and Salop; in Scotland, Dundee, which indeed may be regarded as the chief seat of the British manufacture (*Geographical Dictionary*, art. 'Dundee'); and in Ireland, the province of Ulster. The entire value of the linen manufacture of Great Britain and Ireland is estimated at 14,000,000*l.*, and the total number of persons employed in it upwards of 200,000, a great impulse having been given to the manufacture by the dearth of cotton.

Ling. The *Calluna vulgaris* or Common Heather. The name is also given in China to *Trapa bicornis*.

LING. In Ichthyology, the *Gadus Molva* of Linnæus; a species of cod inhabiting the northern seas. It is salted in large quantities.

Linga. The Hindu name for the emblem known as the Phallus among the Greeks. The Ashera, mentioned in the Books of Kings as set up in the house of Jehovah at Jerusalem, and translated *grove* in the authorised version, seems to have been an emblem of the same kind. [PHALLUS.]

Lingua (Lat. *a tongue*). In Entomology, the name of an organ situated within the labium or emerging from it, by which insects, in many cases, collect their food and pass it down the pharynx, which is situated above its root.

Lingua Franca. The dialect spoken chiefly along the European and African coast of the Mediterranean. It is a species of corrupt Italian, mingled with words of other languages, and may be termed the Creole of the Mediterranean.

(Lat. dim. of lingua). A genus of Palliobranchiate Bivalves with two nearly flat, smooth, oblong, triangular valves, attached between the two apices to a long fleshy pedicle. The arms, or labial appendages, are spirally involuted, as in the rest of the class.

Lingula Flags. A group of deposits chiefly composed of coarse flag stones, but in all nearly two thousand feet thick, and remarkable as yielding an infinite multitude of specimens of a peculiar bivalve shell, the *Lingula*, whence the name of the deposit.

The Lingula flags, though certainly very old, are not the most ancient rocks within the compass of the British Islands. They belong to the middle member of the lower Silurian series overlying the Harlech grits. They have sometimes been called *Cambrian*, as occurring in the district once known as Cambria; but they are not sufficiently distinctive as a group to justify the name.

(Lat. linimentum, from linio, *I besmear*). A semi-fluid ointment, or a soapy application, to rub upon painful joints. The term is also applied to spirituous and other stimulating applications for external use.

Linine. A bitter principle obtained from the *Linum catharticum*, or purging flax.

Lining. In Architecture, any covering of an interior surface. The linings, for instance, or boxings of window shutters, are the pieces forming the backs of the recesses into which the shutters are folded. In doorways, they are the facings on each side of the aperture; to sashes, they are the vertical pieces parallel with the surface of the walls. In Engineering, linings are sometimes applied to prevent the radiation of heat from the surface of a cylinder or steam pipe.

Links (Swed. lånk, *a ring*: Wedgwood). Short connecting pieces in a steam engine, with bearings at both ends, for transmitting motion from one rod, or lever, to another. The link motion is an ingenious contrivance for working the slides, without a separate expansion gearing. [STEAM ENGINE.]

Linnæan System. [BOTANY.]

Linnæite. Native sulphide of cobalt, in which the cobalt is sometimes partly replaced by nickel or copper. It was first noticed in Sweden by Linnæus, and named after him.

Linnet. The *Fringilla cannabina* of Linnæus. A small song bird allied to the goldfinch and siskin. It is often confused with the Redpole (*Fringilla linaria*).

Linseed. The seed of the flax plant, *Linum usitatissimum*.

Linsenerz or **Linsenkupfer** (Ger.). Native octahedral arseniate of copper. [LIROCONITE.]

Lint. A soft woolly material made by scraping old linen by hand; it is also made by machinery. It is used in Surgery for dressing wounds and ulcers, either alone or spread with some ointment.

Lintel (Fr. linteau). In Architecture, horizontal piece of timber, or stone, inserted over a door, window, or other opening, to discharge the superincumbent weight.

Linum (Gr. λίνον). The genus of the Flax, the common Flax being *L. usitatissimum*. This is an annual with smooth erect slender stems, narrow pointed leaves, and blue flowers, and is largely cultivated for its fibre, which forms the linen of commerce.

Flax has been grown for its fibre from the earliest times of which we have any record. The books of the Old Testament afford ample proof of its antiquity as a material for weaving cloth; and representations of its culture occur in ancient Egyptian pictures which have come down to us. The plant was cultivated by the early Romans; but as their clothing was chiefly made of wool, it did not find much favour.

In modern times the culture of Flax is widely spread in the northern hemisphere, extending from the tropics in India and Egypt to the northern parts of Europe. The principal producing country, from which we obtain the greater portion of our supply, is Russia, flax being an important crop in the northern districts of that country; but large importations are likewise received from Belgium, Holland, Prussia, and other countries, in addition to which a considerable quantity is annually produced in our own country, mainly, however, in the north of Ireland.

The processes which flax undergoes before it reaches the hands of the spinner, vary in different places, but the general principle is the same in all, and although many new processes have been invented for shortening the time occupied by the various stages, none has yet entirely superseded the old modes. They may be said to consist of six operations: *Rippling*, or the removal of the seed capsules by drawing the stem through a kind of comb. *Steeping* or *watering*, the object of which is to facilitate the separation of the fibre from the wood, and to get rid of the mucilage. To accomplish this, the flax-straw is tied in bundles and placed in ponds or rivers, where it is allowed to remain for a period of eight to twelve days, when it is taken out, and then undergoes *grassing*, the bundles being untied and the straw spread out evenly and regularly on pasture land, and frequently turned so as to expose both sides to be washed and bleached by exposure to the rain and sun. Then follows *breaking*, by which operation the woody part of the stem is broken previous to *scutching*, which removes all the broken fragments left adhering after the last process. These two operations are generally effected by machinery, but were formerly performed by hand labour. After scutching, flax finds its way into the market, but before being used by the spinner it undergoes a sixth operation called *heckling*, which removes all extraneous matter and completely separates and arranges the filaments in parallel order. It consists in drawing the flax over sharp iron spikes arranged in a quincunx manner and inserted into oblong pieces of wood.

The seeds of the Flax plant, known as Linseed, are a commercial article of considerable importance, for the supply of our oil-mills. The finest kind of linseed oil is the product of simple pressure, and is called *cold drawn*; but the ordinary kind is obtained by breaking up, beating, and re-pressing the marc or cake left after the last process. It is a non-drying oil; but by boiling with sugar of lead, red-lead, or white vitriol, it is converted into a drying oil fit for the use of painters, by whom it is most extensively employed. The cake is greatly valued by agriculturists for feeding purposes; and in addition to that made in this country, large importations are received from abroad. [FLAX.]

Mr. Darwin has recently (*Journal of Linnæan Society*, vii. 69) directed attention to the dimorphism which exists in the flowers of *Linum*, by which means they become functionally, though not structurally, unisexual.

Lion. *Felis Leo* (Linn.). The largest, most formidable, and most noble of the Carnivorous animals, though not the most typical of the genus *Felis*. It is chiefly distinguished by the presence of a full-flowing mane in the male, and by a tufted tail and the disappearance of the feline markings in both sexes before they arrive at maturity; the colour then being a nearly uniform light fulvous brown, with mane inclining to black, especially in the Central and South African races. The mane is scantier and lighter coloured in the Asiatic than in the African lions; and there exists a maneless variety in the eastern parts of Hindustan. [FELIS.]

LION. In Heraldry, a beast, of which the figure is very commonly borne as a charge. The attitudes in which the lion is represented are very various. [RAMPANT, PASSANT, REGARDANT, GARDANT, COUCHANT, SALIENT, SEJANT.] A lion passant is termed, in French heraldic language, *a leopard*; and hence the common notion that the lions of England were substituted for leopards.

Lion Ant. [MYRMELEON.]

Lion of England. A lion passant regardant or (being the bearing of England) is frequently thus termed in heraldry.

Lip (Lat. labium). A term applied to either of the two divisions of a monopetalous corolla, where one portion takes a direction upwards and the remainder a direction downwards, as in *Labiatæ*. It is the same as LABELLUM [which see].

Liparis (Gr. λιπαρός, *glistening*, from λίπος, *fat oil*). The name of a genus of Lepidopterous insects; also applied by Pliny to a genus of fishes. In Botany, it is the name of a genus of plants of the Orchidaceous order.

Liparite. [FLUOR SPAR.]

Liparocele (Gr. λιπαρός, and κήλη, *a tumour*). A fatty tumour.

Lipic Acid (Gr. λίπος, *fat*). An acid formed by acting upon stearic and oleic acid, by means of nitric acid.

Lipogrammatic Works or **Writings** (Gr. λείπω, *I omit*, and γράμμα, *a letter*). Compositions in which a particular letter is omitted throughout. The ancients produced many ingenious trifles of this description. In the *Odyssey* of Tryphiodorus there was no A in the first book, no B in the second, and so on. There are other pieces of modern invention, such as the *Pugna Porcorum*, in which all the words begin with the letter P. Odes in Spanish, containing only one of the vowels, are refinements on the same invention.

Lipoma (Gr. λίπος, *fat*). An encysted fatty tumour.

Liporna (Gr. λίπος). A soft fatty tumour.

Lippitudo (Lat. from lippus, *blear-eyed*). The disease commonly called *bleared eyes*, consisting in a puriform exudation from the margin of the eyelids, which often causes them to adhere together after sleep.

Liquation. [ELIQUATION.]

Liquefaction (Lat. liquefactio). The act of melting or of fusing. This term is also used synonymously with *solution*.

Liqueurs (Fr.). This term is applied to a great variety of foreign compounded spirits. In France they are known as *ratafias* and *crêmes*: they are generally alcoholic solutions or tinctures, sweetened and variously flavoured. The varieties of *noyau* are flavoured with prussic acid and essential oil, derived from the bitter almond, peach and apricot kernels, and similar sources. *Maraschino* is prepared in Dalmatia from a cherry called *marasquin*, which is bruised, fermented, and distilled; its flavour is derived from the kernels of the fruit and some peculiar product of its fermentation, the alcohol being formed from its saccharine matter: the distilled product is afterwards sweetened, and sometimes coloured. *Curaçoa* is a tincture of orange berries and orange peel, cloves, and cinnamon, in old brandy, to which syrup is subsequently added. For *colourless curaçoa* the tincture is distilled, and the distillate afterwards sweetened. *Kümmel* (a favourite German liqueur or *schnaps*) is sweetened spirit of caraway. Tea, coffee, and innumerable other sources of *flavour* are resorted to. The celebrated *wermuth*, or *crême d'absynthe*, is an analogous preparation from wormwood.

Liquidamber. A balsam procured in Mexico and Louisiana from the stem of *Liquidamber styraciflua*.

Liquids. In Grammar, the letters *l*, *m*, *n*, and *r* are so called.

Liquor Amnii. The liquid contained in the membrane enveloping the fœtus of most mammiferous animals. It contains mucus, albumen, grape sugar, and the chlorides, sulphates, and phosphates of sodium and potassium in aqueous solution.

Liquor of Cadet. *Alcarsin* or *oxide of cacodyl*. A volatile and very poisonous liquid formed on heating arsenious acid with acetate of potash. It has an extremely disagreeable odour, and its vapour is a powerful irritant to the eyes and nose.

Liquor Sanguinis. [PLASMA.]

Liquor Silicum (Lat.). Liquor of flints. A solution of silicated potash or soda.

Liquorice (Gr. γλυκύῤῥιζα, a plant with *a sweet root*). The extract of the root of the *Glycyrrhiza glabra*, or Officinal Liquorice: it is often called Spanish liquorice or Spanish juice, of which that stamped with the name Solazza, and imported in sticks or bars six or eight inches long, is considered the best. It is in common use as an emollient in catarrh and cough. The so-called *refined liquorice*, rolled into pipes or quills, is often much adulterated. [GLYCYRRHIZA.]

Lirella. In Botany, a term used in describing lichens, to denote a linear shield, with a channel along its middle, as found in *Opegrapha.*

Liriodendrine (Gr. λείριον, *a lily*, and δένδρον, *a tree*). A bitter crystallisable principle obtained from the bark of the root of the *Liriodendron Tulipifera*, a handsome North American tree of the Magnoliaceous order.

Liroconite (from Gr. λειρός, *pale*, and κόνις, *dust*). A hydrated arseniate of copper, occurring crystallised in obtuse rectangular pyramids of a sky-blue or verdigris-green colour in Cornwall, at Huels Multrell, Huel Gorland and Huel Unity, and also in Hungary. The name has reference to the paleness of the streak yielded by the mineral, compared with its natural colour.

Lissencephala (Gr. λισσός, *smooth*, and εγκέφαλος, *brain*). The subclass of mammalia in which the *corpus callosum* is present, but connects cerebral hemispheres as little advanced in bulk or outward character as in the *Lyencephala*; the cerebrum leaves both the olfactory lobes and cerebellum exposed, and being commonly smooth, or with few and simple convolutions in a very small proportion of the largest members of the sub-class. It is composed of the orders BRUTA, CHEIROPTERA, INSECTIVORA, and RODENTIA [which see].

List (derived by Mr. Wedgwood from the lists or hangings with which the tilting yards were hung, and so connected with Dutch lijst, Ital. liccia, lizza, Span. liza, Fr. lices, lisse). The enclosed field or ground wherein the ancient knights held their jousts and tournaments. It was encircled with pales, barriers, or stakes. These were sometimes double, one for each cavalier, to prevent them from coming nearer each other than a spear's length. Hence the expression *to enter the lists* is synonymous with engaging in contest.

The term *lists* was also applied to the space between the exterior and interior line of defences in mediæval fortifications.

LIST. The name given to the border or selvage of a piece of cloth, &c.

List, Civil. [CIVIL LIST.]

Listel or **List.** In Architecture, the same as fillet or annulet.

Listening Galleries or **Listeners.** In Military Mining, the most advanced galleries of a system of countermines; so called because from them the defenders can hear any advancing mining parties of the besiegers.

Listing. In Architecture, the process of cutting off the sappy part of a board is called *listing it.*

Litany (Gr. λιτανεία, *supplication*). This term was applied by the Eastern church in early ages to a special form of prayer which was introduced into the ritual, or used on particular occasions. The term passed into the Western church, where the words *rogatio* and *supplicatio* had before been used in the same technical sense. It appears that some of the Eastern litanies contain the supplication to saints which forms a distinguishing feature of the Roman. The litany in the Book of Common Prayer of the Church of England is mostly translated from the forms of the Western litanies previously used in this country, namely those of the breviaries of Salisbury and York. (Palmer's *Origines Liturgicæ*, i. 264.)

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Literati (Lat.). This word denotes, in general, learned men. In China such persons as are able to read and write their own language, and also a particular sect, consisting chiefly of the most learned men of that country, are called *Jukiao*, or learned. It is from the class of the literati that the MANDARINS [which see] are alone capable of being selected. In this country, the term is now applied chiefly to persons who are admitted into holy orders without having previously taken an academical degree.

Literature (Lat. literæ, *letters*). This word denotes, generally, the entire results of knowledge and fancy preserved in writing; but, in the narrower use to which ordinary custom restricts it, we draw a distinction between literature and positive science, thus exempting from the province of the former one extensive branch of our studies. And, in a still more restricted sense, the word *literature* is sometimes used as synonymous with *polite* literature, or the French *belles-lettres.*

The history of literature is a peculiar and distinct subject, comprising several subdivisions, such as histories of the literature of special ages or countries; or histories of separate branches of literature, such as poetry. For its complete execution it requires a union of bibliographical knowledge with critical acumen. It should give the reader a sufficient acquaintance with the titles, contents, and dates of remarkable books, and with the general biography of remarkable authors, together with a critical appreciation of the characters and value both of authors and books, and of the dependence, connection, and derivation of literature; that is, the mode in which opinions, taste, and style have been propagated or changed. This last, as it is the most difficult part of the subject, is also that of which the execution has been hitherto most imperfect.

In the following brief notices of the principal works of general literary history which the student has it now in his power to consult, we

shall follow, in great measure, the criticisms of Hallam, in the Preface to his *Introduction to the Literature of Europe in the Fifteenth, Sixteenth, and Seventeenth Centuries.* The oldest work of this description (if such it can be called) is that of Polydore Virgil, *De Inventoribus Rerum*, 1499. Conrad Gesner, who has been termed the father of literary history, published his *Bibliotheca Universalis* at Zurich, 1545–55. Notwithstanding these and a few other meagre attempts, Lord Bacon, says Hallam, was justified in denying that, up to his time, any real history of letters had been written. The next in order of time is Lambuc's *Prodromus Historiæ Literariæ*, 1659; a work designed on a great plan, but scarcely begun. But Morhof's *Polyhistor Literarius*, first published in 1688, and much enlarged by subsequent editors, is still found in every considerable library. Andrès, a Spanish Jesuit, published his *Origine, Progresso, e Stato Attuale d'ogni Letteratura*, from 1782 to 1799; a very extensive, and, in some respects, valuable work, though without much display of taste, and no signs of genius. In the present century, no writers, except those of Germany, have attempted a field which has become of such enormous extent; but Eichhorn's *Literary History*, in six volumes, 1805, 1811, appears to be now, on the whole, the most complete and valuable work of this kind extant. Waehler's *Manual of Literary History*, in four volumes, appeared at Leipsig in 1833.

But besides these general compendia, much assistance is to be derived from general biographers. Of these the well-known dictionary of Bayle, first published in 1697, is the earliest of any value. That of Niceron, *Mémoires pour servir à l'Histoire des Hommes illustres de la République des Lettres*, 43 vols. 12mo. 1733, 1745, is extraordinarily copious, and useful in biographical details, but in other respects of no great value. The *Biographie Universelle* (of which the original edition was in 52 volumes, and a supplement is now in course of publication which has reached the letter H) stands first among this class of works. Chalmers's *Biographical Dictionary* scarcely deserves mention as a literary work; but its historical details are sometimes minute and useful, though not unfrequently most so in the obscurest names.

Of *partial* works on literary history some of the most remarkable and useful are: 1. According to subjects—History of Philosophy, Brucker, Buhle, Tennemann (abridged by Victor Cousin). To these we may add, brief as they are, the Introductory Essays of Stewart and Playfair to the *Encyclopædia Britannica.* Of Belles-lettres, generally, Bouterwek, 12 vols. 8vo. Poetry, Quadrio, *Storia d'ogni Poesia*; a work of remarkable industry, though strangely defective in point of critical taste. 2. According to countries—German: the works of Menzel, Vilmar, and others. English: Craik, *History of the English Language and Literature.* Arnold, *Manual of English Literature.* Taine, *Histoire de la Littérature Anglaise.* French: Laharpe, *Cours de Littérature Française*; a performance of considerable, but in parts superficial and showy, talent. Italian: Tiraboschi, *Storia della Letteratura Italiana*; a work of extraordinary value, in which the history of Italian literature has been traced, with the greatest care and the most elaborate research, from the earliest times down to the last century. It has been abridged, but with some original criticism, by Ginguené, in his *Histoire Littéraire de l'Italie*; Corniani, *Secoli della Letteratura Italiana dopo il suo risorgimento*, 1804, 1813. Sismondi's *Littérature du Midi de l'Europe* is most valuable, also, in its Italian chapters, although those on Spanish and Portuguese literature touch on subjects less generally known. In England, Warton's *History of Poetry* contains much that bears on our general learning; but leaves us about the accession of Elizabeth. 3. According to ages: The work of Hallam, which comprehends the literary history of Europe from 1400 to 1700, is almost universal in its character. Its peculiar excellences are a philosophical spirit, manliness and candour of judgment, great honesty in the execution, and a taste unusually cultivated and correct.

Lithagogue (Gr. λιθαγωγός, *bringing stones*). Medicines supposed to have the power of expelling calculous matter from the kidney or bladder.

Litharge, Lythargyrum (Gr. λιθάργυρος, from λίθος, and ἄργυρος, *silver*; probably from its silvery appearance). Fused oxide of lead. [LEAD.]

Lithia (Gr. λίθειος, *of stone*). The oxide of lithium (LiO), an alkaline substance, discovered in 1818 by M. Arfwedson in a mineral called *petalite*; it has also been found in a few other lapideous bodies such as *lepidolite* and *triphane.* It is distinguished from potassa and soda by the difficult solubility of its carbonate; from baryta, strontia, and lime, by the solubility of its sulphate and oxalate; and from magnesia by the alkalinity of its carbonate. It is the oxide of *lithium*; the equivalent of which is 7, and that of lithia 15. The salts of lithia impart a peculiar crimson-red colour to the flame. By spectral analysis traces of lithia appear to have been detected in sea-water, and in many mineral springs.

Lithia Mica. [LEPIDOLITE.]

Lithiasis (Gr. from λίθος). The disease of stone in the bladder or kidney.

Lithic Acid (Gr. λίθος). The substance generally termed *uric acid*: it forms the commonest variety of urinary calculus. [URIC ACID; CALCULI.]

Lithium (Gr. λίθος). This metal (represented by the symbol Li and the equivalent 7) has been obtained by the electro-chemical decomposition of its chloride: it is white, softer than lead, fusible at 356°, and volatile at a full red heat; it decomposes water. When heated in the air it burns with an intense white light, forming lithia. Lithium is the lightest known solid; its specific gravity being 0·539,

so that it floats upon naphtha. Carbonate of lithia has been used in medicine as a lithontriptic, in cases of uric sand and gravel; it dissolves uric acid somewhat more freely than the carbonate of potash or soda. [LITHIA.]

Lithochromatics (Gr. λίθος, and χρῶμα, *colour*). A term applied to painting in oil upon stone, and taking impressions upon canvas.

Lithocolla (Gr.). A cement for stone-work.

Lithodendron (Gr.). Coral has been thus designated, from its frequent arborescent appearance.

Lithodermis (Gr. λιθόδερμος, *with strong skin*). A genus of Apodal Echinoderms, in the system of Cuvier; characterised by an oval body compressed posteriorly, of which the surface is covered with a layer of calcareous granules, which form an extremely indurated crust.

Lithodomes (Gr. λιθοδόμος, *building with stone*). This term is applied to those bivalves which are found in rocks and stones, inhabiting cavities, which they form for that purpose. A particular genus is called *Lithodomus*.

Lithofellic Acid (Gr. λίθος, *a stone*, and Lat. fel, *gall*). A substance obtained by Göbel from a Bezoar stone. In 1844, Taylor made the curious discovery of the identity of the substance constituting the so-called *Oriental Bezoars*, which are probably the intestinal concretions of a species of antelope, with the acid called *Ellagic acid*, contained, along with tannic and gallic acids, in the gall nut.

Lithographic Stone (Gr. λίθος, and γράφω, *I draw*). A limestone splitting into plates and slabs of moderate thickness, and having a sufficiently hard smooth and absorbent surface to be adapted for use for lithographic purposes. The best of such stones are from the upper oolites of Pappenheim and Solnhofen in the North of Bavaria. Very good stones are also obtained from the lias in many other parts of Europe, and some from beds of other geological periods.

Lithography. [ENGRAVING.]

Lithological (Gr. λίθος, and λόγος). A term expressing the stony structure or character of a mineral mass. We speak of the *lithological* character of a structure, as distinguished from its *zoological* character.

Lithomarge (Gr. λίθος, and Lat. marga, *marl*). Stone-marrow. A hydrous silicate of alumina of various colours, generally associated with magnesian minerals. The term has, however, been applied by mineralogists to several substances, some of which are mere products of the decomposition of other minerals.

Lithontriptics (Gr. λίθος, and τρίβω, *I rub away*). Remedies which are supposed to dissolve stone in the bladder, or which prevent the deposition of calculous matter in the urine.

Lithontriptor. An instrument for breaking calculi in the bladder, so as to reduce them to small particles which may admit of being passed along with the urine, and thus render the operation of lithotomy unnecessary.

Lithophagi (Gr. λίθος, and φάγω, *I eat*). Molluscous animals which bore into stones. [LITHODOMES.]

Lithophytes (Gr. λίθος, and φυτόν, *a plant*). Polypes which have a stony axis; as distinguished from the Keratophytes, or horny polypes.

Lithornis (Gr. λίθος, and ὄρνις, *bird*). A genus of vulturine birds, of which fossil specimens are found in the Eocene clay at Sheppey.

Lithotomy (Gr. λιθοτομία). The operation of cutting into the bladder for the removal of a stone.

Lithotrity (Gr. λίθος, and Lat. tritus, part. of tero, *I rub* or *wear away*). The operation of breaking a stone in the bladder into small pieces capable of being voided by urine: it is effected by the introduction of instruments by the urethra, and under skilful management has in many instances successfully superseded the more formidable operation of lithotomy.

Litmic Acid. The chief constituent of the ordinary litmus of commerce.

Litmus. A blue pigment obtained from various lichens, among which species of *Roccella*, *Lecanora*, and *Variolaria* have been especially resorted to; it is often called *turnsol*, and yields the dye called *archil*. Paper tinged blue by litmus is reddened by the feeblest acids, and hence is used as a *test* of the presence of acids; and litmus paper which has been reddened by an acid has its blue colour restored by an alkali. Distinct colouring substances have been obtained from litmus, such as lecanorine, orcine, erythrine, &c. [LICHEN.]

Litotes (Gr. λιτότης, from λιτός, *plain*). In Rhetoric, a figure, according to the Greek and Latin rhetoricians, in which an affirmative is expressed by the negative of the contrary; it is, therefore, a species of irony in the ancient sense of the word [IRONY], in which less is expressed than what is intended to be conveyed to the mind of the reader or hearer. Thus, 'a citizen of no mean city' means 'of an illustrious city.' It is a figure constantly employed to soften what might otherwise appear obnoxious in self-commendation.

Litre. The French standard measure of capacity in the decimal system. The litre is a cubic decimetre; that is, a cube, each of the sides of which are 3·937 English inches: it contains 61·027 English cubic inches. Four and a half litres are a close approach to the English imperial *gallon*.

Littorina (Lat. littus, the *seashore*). A genus of Pectinibranchiate Molluscs of the tribe *Trochoida*; characterised by its thick shell, of which the aperture presents a small angle, and is without a ridge. The common periwinkle of our coasts (*Turbo littoreus*, Linn.) is a species of this genus.

Liturgy (Gr. λειτουργία). At Athens, certain public services, performed by the wealthier citizens, were called Liturgies. Among the ordinary liturgies were the Choregia, Lampadephoria, Hestiasis, &c.; the extraordinary liturgy was the Trierarchia, or the duty of equipping and manning ships for the Athenian fleet. In later times these services, when too

expensive for one citizen, were performed by two, whose partnership was termed Συντέλεια; the members in these partnerships for contributing ships was much larger; and such societies were also called Symmoriæ. On the mismanagement of this service, and the reforms proposed by Demosthenes, see his oration *De Coronâ*. It is from this term that the English LITURGY, in its ecclesiastical meaning, has been derived; the sense having been contracted from public *ministry* or service in general to the ceremonies of religious worship.

LITURGY. The ritual according to which the religious services of a church are performed. In the writings of the ancients the name is restricted to the service of the Eucharist, which afterwards came to be distinguished in the Western church by the term *missa*, or mass.

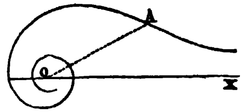
There still exist in Greek, Latin, and some Oriental languages, various rituals according to which the Eucharist was celebrated in very early ages. Some have supposed that all these may be referred to one original liturgy, which may have been universally adopted in the primitive church. Palmer (*Antiq.* vol. i. p. 8) conceives that the number of original liturgies may be reduced to four, but not lower. These he entitles the great Oriental liturgy, the Alexandrian, the Roman, and the Gallican; each of which was extensively used from the apostolic age in the quarters from which he assigns them their names, and became the parents of many other rituals, such as were used, with many variations, in the different patriarchates of the empire.

The earliest period at which any liturgical forms were consigned to writing is the end of the third or beginning of the fourth century; at least the liturgy called of St. Basil can be traced as high as the latter period. This practice, also, seems frequently to have been applied only to certain parts of the service. We find, therefore, great differences in the MSS. which now exist; and it becomes very difficult to ascertain what the contents of the primitive rituals were, and to trace the periods at which many rites and ceremonies have been introduced into the service.

The liturgy of the church of England is a liturgy in the wider and more usual acceptation of the term, comprehending the whole of the various services used on ordinary and extraordinary occasions throughout the year. For the history of this liturgy, see COMMON PRAYER. See also Assemanni, *Codex Liturgicus*; Muratori, *Liturgia Romana Vetus*; Breff's *Collection of Liturgies*; Palmer's *Origines Liturgicæ*; Maskell's *Monumenta Ritualia Anglicana*.

Lituus (Lat.). Among the Romans, a crooked staff, resembling a crozier, used by the augurs in quartering the heavens. The origin of the word is uncertain.

LITUUS. In Geometry, the name given by Cotes to a spiral, of which the characteristic property is that the squares of the radii vectores are reciprocally proportional to the angles which they respectively make with a certain straight line OX given in position, and which is an asymptote to the spiral. The polar equation is obviously $r^2\theta = a^2$. It has a point of inflexion at A corresponding to the value $r = OA = a\sqrt{2}$. For the properties of the lituus, see Varignon, *Mém. Acad. Paris* 1704; Cotes, *Harmonia Mensurarum*, p. 85; Peacock's *Examples in the Diff. and Integral Calculus*, p. 183 &c.



Liver (A.-Sax. lifere, Ger. leber). The viscus in which bile is secreted. It is situated in the right hypochondriac region under the diaphragm; and in the human body is divided into two lobes, of which the right lobe is the largest. There is between them a smaller lobular process, called the *Lobulus Spigelii*. The ultimate arrangement of the different blood-vessels of the liver is very peculiar. It has been ably investigated by Mr. Kiernan, by whom it is described in the *Phil. Trans.*

Liver of Antimony. A compound of the oxide and sulphide of antimony. The *hepar antimonii* of old pharmaceutical chemistry.

Liver Ore of Mercury. *Hepatic ore.* A bituminous Cinnabar, or sulphide of mercury, from Idria in Carniola.

Liver of Sulphur. Fused tersulphuret of potassium: so called from its *liver colour*.

Livery (Fr. livrée). A word derived, probably, from the clothes *delivered* by masters to their servants, in which sense it still continues to be used. At tournaments the cavaliers used to distinguish themselves by wearing the livery or badge of their mistresses; and persons of distinction formerly gave liveries to persons unconnected with their own household or family, to engage them in their quarrels for the time being. The *liverymen* of London are a number of men belonging to the freemen of the ninety-one companies, which embrace the different trades of the metropolis; and are so called because they are entitled to wear the livery of their respective companies. By this body are elected the common councilmen, sheriffs, aldermen, and some other superior officers of the city; and, down to the passing of the Reform Bill in 1832, they had the exclusive privilege of voting at the election of members of parliament.

Livery of Seisin. In Law, a delivery of possession in lands, tenements, and hereditaments, to one that has a right to the same: a ceremony at common law used in the conveyance of lands, whereby an estate of freehold passes by feoffment. [FEOFFMENT.]

Living Force or **Vis Viva** (Lat.). In Mechanics, the product of the mass of a particle into the square of its velocity. [FORCE.]

Livre (Fr.; Lat. libra, *a pound*). An ancient French coin, which appears as early as 810 A.D. It was at first divided into twenty *solidi*, and afterwards into twenty *sous*. At the French revolution the *franc* was substituted for the livre.

Lixivium (Lat. *lye*). A term employed by the old chemists to signify an alkaline ley or solution.

Lizard. [LACERTA.]

Llandeilo Flags. A group of hard dark-coloured sandy or gritty beds readily splitting into flag-stones. This group is of considerable local importance, and belongs to the Silurian series developed in South Wales. The flags lie near the top of the lower division of the Silurian rocks, as recognised by Sir R. Murchison, passing into the lower subdivision of the Caradoc sandstone, part of which is Upper Silurian. The Llandeilo flags are rich in fossils, *graptolites* being especially abundant in them. They also contain valuable metalliferous veins in Shropshire. They are represented in France by the slates of Angers, and in America by the Utica slates. It is chiefly in Wales that they exhibit that fissile character which has given them the name of flags. They afford many stones useful for paving and other economic purposes.

Llanos (Lat. planus, *level*). Tropical plains, continuations northward of the forest plains of the Amazons. [SILVAS.] Their area is about 350,000 square miles, and the whole are destitute of trees. They consist of low table-lands, nearly barren for the most part, sloping at first, and then ranging at a dead level between the Amazons and the Caribbean Sea. These are called the *Llanos altos*. The larger plains are lower, but also nearly barren, the soil being sand over calcareous rock without rocks or pebbles. Although without cultivation, grasses and a few bushes cover parts of these plains.

Lloyd's List. A well-known periodical publication, which contains a full account of shipping intelligence. It derives its name from Lloyd's coffee-house, so long celebrated as the resort of all classes connected either with the mercantile or shipping interest; and its importance in supplying full, trustworthy, and early maritime information cannot be easily overrated. It has been in existence since 1716.

Loach. [COBITIS.]

Load-line. In designing a ship, the load-line is the supposed line of deepest immersion when she is fully laden. Vessels are usually so built that the immersion shall be deeper aft than forward.

Loadstone. [LODESTONE.]

Loam (A.-Sax. lam, Ger. leim, *clay*). A variety of clay in which there is sufficient sand and limestone to render it loose in texture and well adapted to such crops as require a soil in which they can readily expand and assume their natural dimensions. The quantity of silica which clays are capable of holding mixed up with them without losing their peculiar characteristics is very large, amounting in some cases to nearly ninety per cent. of the whole soil.

Loamy Soil. In the language of practical agriculturists and gardeners, is one in which clay exists: it is called *heavy* or *light*, as the clay may be more or less abundant; and sandy, gravelly, or calcareous, as these earths predominate respectively in the composition. In general, loamy soils are more fertile than sand or chalk; but the fertility of any soil is always to a certain extent relative to the nature of the subsoil, and to the local climate.

Loan. In Finance, a term employed to designate such advances for the purposes of national administration as are demanded by temporary exigencies. In the middle ages, when public credit was low, and the method of joint action familiar to modern capitalists, for the purpose of contributing to the necessities of government by voluntary subscription, was unknown, violent means were resorted to in order to meet any emergency; though in general the compulsory contribution was coupled with a delusive promise of repayment. Borrowing was a frequent expedient of government before the Revolution; but no effectual guarantee for the liquidation of the principal sum borrowed, or for the punctual payment of interest on advances, was given till after the settlement of 1688. Since this time, however, it has been found essential to the security of government, that trustworthy pledges for the guarantee of public debts should be afforded to lenders; and one by one European and other civilised communities have entered into obligations intended to secure public credit, and have been constrained more or less exactly to keep such obligations.

In general, loans are negotiated by individuals or banking houses, who contract to supply the borrowing government with the sum required, either in a variable quantity of money, but a fixed quantity of stock, or in a fixed sum of money at a varying rate of interest. The former is the method which has generally been adopted in this country; the finance minister advertising for tenders of so many millions of stock, and trusting that the competition of capitalists will raise the percentage paid for the stock to the highest rate which the money market will permit. Hence a large portion of the national debt of the United Kingdom is in effect factitious, the nation not having received much more than three-fifths of the sum which is taken as the existing indebtedness of the community to its public creditor. The question, indeed, whether this method of borrowing is ultimately advantageous or the contrary, is still matter of debate; it being urged, on the one side, that the extinction of debt is rendered more difficult by the creation of so large an amount of factitious obligations; and on the other, that the terms on which the loan is procured are always more favourable when the rate of interest is invariable, and the stock therefore uniformly negotiable.

In most other countries, loans have been effected at variable rates of interest. Such a method has this advantage, that when public credit is high, and capital abundant, it is possible to lower the rate of interest on loans already effected, by offering the public creditor the choice of repayment, or as an alternative a diminished percentage on his capital. Large amounts of stock in this country have, at

different periods, been virtually extinguished by the possibility which has sometimes occurred of offering lower terms to the public creditor in consequence of the price of the stock having risen above par. In short, the government has been enabled to do that which a mortgagor does who, taking advantage of a low rate of interest, extinguishes one mortgage, and creates another on more favourable terms.

The government of this country has from time to time negotiated loans on the latter method. Its first loans were all of such a nature, the other system having been adopted after the consolidation of the various three per cent. stocks in 1752. Still, though the greater part of the sum borrowed was funded in perpetual annuities at three per cent. (called, by an abbreviation of the term used in the Act of 1752, *consols*), other portions were created in other stocks. For instance, in a loan negotiated in 1794, the lender of 100*l.*, in addition to 100*l.* stock in consolidated annuities, received 25*l.* four per cents. and an annuity of 11*s.* 5*d.* for 66¼ years. The 'loyalty loan' of 1797 was negotiated in a five per cent. stock. It rarely happens, of course, that the lender can, in case of bad faith on the part of governments, use any means in order to compel payment; but the police of the Stock Exchange exercises a powerful control over a dishonest administration, by excluding, in the case of fraud or repudiation, all the transactions of the offending government from the open money market. [NATIONAL DEBT.]

Loasaceæ (Loasa, one of the genera). A natural order of epigynous Exogens belonging to the Cactal alliance, found chiefly in the temperate regions of America, and distinguished by their distinct petals and sepals, their scattered stamens, their confluent pendulous ovules, and albuminous seeds. The principal genus, *Loasa*, consists of stinging herbs.

Lobate (Gr. λοβός, *a lobe*). A term applied by Linnæus to the feet of those birds, as the grebe, which were furnished at their sides with broad-lobed membranes.

Lobby. In a ship, a small cabin adjoining the bread-room, and appropriated to the use of the surgeon.

Lobeliaceæ (Lobelia, one of the genera). A natural order of epigynous Exogens of the Campanal alliance, especially distinguished by its valvate irregular corolla, its syngenesious anthers, its stigma being surrounded by hairs, and its two or more celled ovary. They are mostly herbs or subshrubs, abounding in various parts of the world, in tropical or subtropical climates, and include the important genus *Lobelia*, many species of which have acrid properties, and are also used in medicine. One of them, *L. inflata*, a North American species, called Indian Tobacco, is a powerful narcotic poison. Its leaves have been used in medicine as an expectorant and emetic. They are said to quiet the action of the heart and relax the muscles, and to be of great use in allaying the paroxysms of spasmodic asthma, and as a relaxant in hooping-cough.

Lobeline. A peculiar acrid oil, contained, along with *Lobelic acid*, in the leaves of the *Lobelia inflata*.

Loboite. A magnesian variety of Idocrase from Gökum in Finland.

Lobster. A well-known Crustacean, the *Palinurus vulgaris* of Cuvier. Several species are used as food on the Continent, but the Norway Lobster is the only important one brought to the British market. The peculiar colouring matter of the shell changes from black to red when immersed in boiling water.

Local Problem. In Geometry, a problem in which the number of given conditions being insufficient to determine the position of a point, but still sufficient to prevent this position from being perfectly arbitrary, the curve or surface is required upon which the point must be situated. Thus, 'to find all points equidistant from two given fixed points,' is a local problem. The right line which bisects, and is perpendicular to the line joining the given points, contains all the points required, and constitutes the solution of the problem. [DETERMINATE PROBLEM.]

Locative Case. In Grammar, the case expressive of locality. Such a case existed originally in all the Aryan languages; but in the later dialectical formations it has been confused with other cases owing to the similarity of the suffix by means of which it was constructed. This suffix in Sanscrit, which retained the case in all numbers, is *i*; and it was manifestly the same in Greek and Latin. Thus, when our ordinary grammars tell us that in the phrase, 'Romæ vixit,' *he lived at Rome*, Romæ is in the genitive case, they fall into the great error of confusing the genitive case with the locative Roma-i = Romæ. Hence arises that most confusing and mischievous of grammatical rules, which tells the learner that position at a place is in Latin to be expressed by the genitive singular of the first and second declensions of nouns, but by the dative or ablative case of the singular number with nouns of the third declension, or of the plural number of the first. Instead of this rule, which has neither rhyme nor reason to recommend it, all that is to be said is that these so-called genitives and ablatives are really the old locative case, as may be seen by comparing Roma-i = Romæ, Abyd-i, Carthagin-e, Athen-is, with Σπαρτῇ, Σαλαμῖν-ι, Ἀθῆνα-ις, &c. It was only in later Latin that the locative assumed the same form with the genitive, the original termination of the latter in the first declension being in -as, as shown by the form 'pater-familias'; and, indeed, the idea of any genitive at all is seemingly of later growth, everything that is abstract in language having been originally concrete. (Max Müller, *Lectures on Language*, first series, vi.)

Loch. The Scotch term for LAKE [which see]. [LOUGH.]

Lochaber Axe. [BATTLE-AXE.]

Lock (A.-Sax. loc). An instrument composed of springs and bolts, used for the fasten-

ing of doors, drawers, chests, &c. A good lock is a masterpiece of smith's work, and requires much delicacy and art in contriving and varying the wards, bolts, springs, and other parts of which it is composed, so as to adjust them to the places where they are serviceable, and to the various occasions of their use. The structure of locks is so varied, and the number of inventions of different sorts so extended, that we cannot attempt to enumerate them. Those placed upon outer doors are called *stock-locks*; those on chamber doors are called *spring-locks*; such as are hidden in the thickness of the doors to which they are applied, are called *mortice-locks*; and those that are applied upon the outside of the doors are called *iron rimlocks*. The padlock is too well known to require description. We here add the conditions which, according to Mr. Nicholson, appear necessary in a lock of the most perfect kind: 1. That certain parts of the lock should be variable in position through a great number of combinations, one only of which should allow the lock to be opened or shut; 2. That this last-mentioned combination should be variable at the pleasure of the possessor; 3. That it should not be possible, after the lock is closed and the combination disturbed, for anyone, not even the maker of the lock, to discover by any examination what may be the proper situation of the parts required to open the lock; 4. That trials of this kind should not be capable of injuring the lock; 5. That it should absolutely require no key, and be as easily opened in the dark as in the light; 6. That the opening and shutting be done as easily, and by a process as simple, as a common lock, either with or without a key, as may be desired; 7. That the keyhole be defended, concealed, or inaccessible; 8. That the key may be used by a stranger without his knowing, or being able to discover, the adopted combination; 9. That the key be capable of adjustment to all the variations of the lock, and yet be simple; 10. That the lock should not be liable to be taken off and examined, whether the receptacle be open or shut, except by one who knows the adopted combination. These considerations involve a mechanical problem of great difficulty; but much towards its accomplishment has been effected in various inventions by Bramah, Chubb, Taylor, Hobbs, &c. The Romans seem to have known the use of tumblers in their locks, if we may judge from the specimens from Pompeii.

Lock. That part of a musket or fowling-piece which has to do with the ignition of the charge by percussion.

Lock. In internal Navigation, the part of a canal included between two floodgates, by means of which a vessel is transferred from a higher to a lower level, or from a lower to a higher. It is also applied to the contrivance by which vessels are maintained at the level of high tides in harbours exposed to variations of level. [Canal.]

— On Shipboard, compartments of the hold for the stowage of chain cables and solid shot. They are centred round the foot of the mainmast; that position for these weighty objects being found to give the easiest motion to the ship as she pitches in a head sea.

Lockjaw. [Tetanus.]

Locomotion (Lat. locus, *a place*, and motio, *a moving*). Such motion as is attended by change of place in the body which moves, in contradistinction to motions which a body may have which is stationary. Thus a clock, a mill, a lathe moves; but as no change of place of the machine is produced, such *motion* is not locomotion. A steam engine which being fixed in its position impels other bodies, is a stationary engine; but one which travels with the bodies which it drives is called a *locomotive* engine.

Locomotive Engine. Any engine which, being employed to draw loads in transport overland, travels with the load which it draws.

Since the improvement and extension of iron railways, this term has been exclusively applied to the steam engines by which loads are drawn upon them. Although, strictly speaking, the steam engine by which a ship is propelled is a locomotive engine, it is not usual to apply that term to it; such an engine being called a *marine engine*. [Steam Engine.] The term *locomotive engine* must, therefore, as at present used, be understood to express the travelling steam engine by which trains are drawn on railways.

History of the Locomotive Engine.—The first practical application of the steam engine as a locomotive power took place in 1804, on a railroad at Merthyr Tydvil, in South Wales. The engine was constructed by Messrs. Trevithick and Vivian, under a patent obtained by them two years previously. This engine, in several respects, resembled in its form and structure those which have been since used for a like purpose.

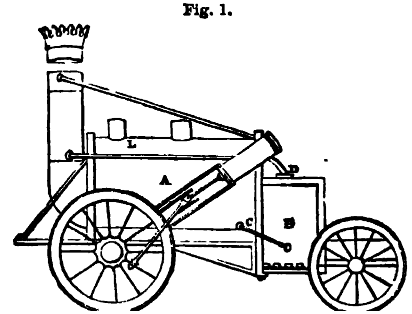
The early projectors of locomotive engines were all impressed with a notion that the adhesion of the driving wheels to the rails must be insufficient to enable the power applied to these wheels to give progressive motion to the carriage; and, without thinking it necessary to ascertain by actual experiment whether such were really the case or not, they expended much ingenuity and capital in devising means for overcoming this difficulty, which, after all, turned out to be merely imaginary. Engineers were, in fact, impressed with a notion that if any power compelled the wheels to revolve, they would merely slip upon the rails, and that the carriage or engine would remain stationary. To provide against this, Messrs. Trevithick and Vivian proposed to make the external rims of the wheels intended for common roads rough and uneven, by surrounding them with projecting heads of nails or bolts, or by cutting transverse grooves in them. Seven years afterwards Mr. Blenkinsop, of Leeds, obtained a patent for a method of surmounting this imaginary difficulty by the substitution of a rack rail for the ordinary smooth rail, and constructing teeth on the driving wheels to work in the teeth of this rack. Various other ingenious contrivances

were subsequently produced for the same purpose until about the year 1814, when experience at length forced upon engineers the knowledge of the fact, that the adhesion of the tires of the wheels with the rails was amply sufficient to propel the engine, even when drawing a great load after it.

The next stimulus which the progress of this invention received arose from the project of constructing a railway between Liverpool and Manchester, for the purposes of a general traffic. When this project was undertaken, it was not decided what moving power was most eligible — whether horse power, stationary steam engines, or locomotive engines; but the first, for many obvious reasons, was soon rejected, in favour of one or other of the last two, and after an elaborate enquiry the decision of the directors was given in favour of locomotive power. Prizes were therefore proposed to be given, under certain stipulations, to those who would construct the most effective locomotive engines for the purposes of the road.

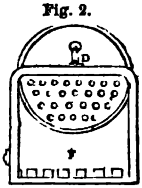
This proposal produced, as was anticipated, much competition; and the spirit of emulation being roused, a trial was appointed, which took place on the railway in October 1829. Engines of several forms were produced; and the prize was awarded to one, called the *Rocket*, constructed by Mr. Robert Stephenson, the son of Mr. George Stephenson, the engineer of the railway. (Jeaffreson and Pole, *Life of Robert Stephenson.*) In the first trial, this engine attained the then astonishing speed of twenty-nine miles an hour; and when, unhappily, at the ceremony of the opening of the railway, the accident occurred which deprived the country of Mr. Huskisson, his wounded body was conveyed, by the same engine, a distance of about fifteen miles in twenty-five minutes, being at the rate of thirty-six miles an hour. This engine, which involved in its construction all those mechanical arrangements to which the extra-

Fig. 1.



ordinary speed and power of the locomotive engine of the present day are due, is represented in elevation in fig. 1; and a cross section of the boiler and furnace is represented in fig. 2. It is supported on four wheels, the weight being principally thrown on the larger pair worked by the engine. The boiler is a cylinder 6 feet long, having the chimney at one end, and the fire box B at the other. This box is surrounded with a hollow casing, which communicates with the bottom of the boiler by a tube C, and with the top by a tube D. The water in the boiler, therefore, flows into the casing, and fills it to the same level as that which it has in the boiler. When the engine is at work, the boiler is kept about half filled with water, and, consequently, the casing round the furnace is completely filled. Steam is abundantly generated in this casing, exposed as it is on every side to the radiant heat of the fire; this steam rises in bubbles, and passes through the tube D into the boiler. The lower part of the boiler is traversed by a number of copper tubes, the ends of which appear in fig. 2. The flame and heated air proceeding from the burning fuel pass through these tubes, and, after traversing the whole length of the boiler, escape into the chimney, imparting, on their passage, heat to the water in the boiler. The necessary draught through the furnace is maintained by causing the cylinders to discharge the waste steam into a pipe, which is presented up the chimney, and is called the blast pipe. There are two cylinders placed outside the engine, on either side of it, as represented in fig. 1; these are placed in a diagonal position, and their rods move in guides; the end of the piston rod is connected with one of the spokes of the wheels by a connecting rod, and the piston, as it is driven by the steam in each direction in the cylinder, causes the wheels to revolve.

Fig. 2.



The circumstances in this mechanical arrangement, on which the rapid production of steam depends, are twofold; first, the extensive surface exposed to the radiant heat of the fire, by the casing surrounding the fire box, and by the tubes, twenty-five in number and only three inches in diameter, by which the flame and heated air are conducted through the boiler from the fire box to the chimney; and secondly, by the powerful draught maintained in the furnace by the current of steam constantly discharged up the chimney. It has been mainly by bringing these principles more fully into operation, that all the improvements since made in the locomotive engine have been effected.

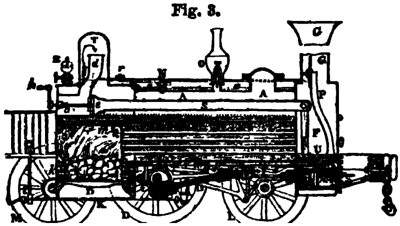
Having thus briefly sketched the history of the locomotive engine, we will now give a description of such a machine in one of its most common forms.

Description of the Locomotive Engine.—A longitudinal vertical section of a locomotive engine is represented in fig. 3; and a plan of the working machinery, including the cylinders, pistons, eccentrics, &c., which are under the boiler, and by the operation of which the engine is driven, is represented in fig. 4.

The boiler, as has been explained in the engines already described, is a cylinder placed upon its side; the fire box consists of two

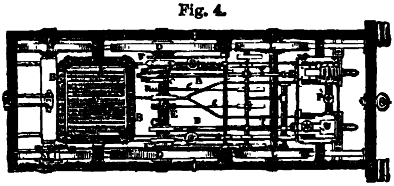
casings of metal, one within the other, bolted together by stays, represented at *k*; the fire grate is represented at D. The fire door is

Fig. 3.



represented at *g*, opening upon the platform where the engineer stands. It will be perceived in the section fig. 3, as well as in the

Fig. 4.



plan fig. 4, that the fire box is on every side surrounded by the water contained between the two casings, the level of the water in the boiler being above the roof of the fire box. The tubes by which the flame, and the products of combustion, are drawn from the fire box into the smoke box, are represented at E, fig. 3. The smoke box containing the cylinders and blast pipe, and supporting the chimney, is represented at F. In the engine from which this drawing was taken, the boiler is a cylinder $7\frac{1}{2}$ feet long and $3\frac{1}{2}$ feet diameter: it is clothed with a casing of wood, represented at *a*, and bound round by iron hoops screwed together at the bottom. Wood being a slow conductor of heat this covering has the effect of keeping the boiler warm and checking the condensation of steam.

The external casing of the fire box, BB, is nearly square in its plan, as seen in fig. 4, being 4 feet wide, and 3 feet $7\frac{1}{2}$ inches long; it is constructed of wrought-iron plates, and descends two feet below the boiler, as seen in fig. 3; the top being semi-cylindrical, of a diameter greater than that of the boiler, and concentrical with it. The inner casing, *kk*, fig. 4, is similar in shape to the external; but it is lower, and flat at the roof, as seen in fig. 3. The space between the two casings is from 3 to 4 inches in width. This internal fire box is made of copper plates.

As the top of the fire box would be liable to be destroyed by the action of the fire if the level of the water in the boiler were suffered to fall below it, so as to leave it uncovered, a leaden plug *m* is inserted in it, which would melt out before the copper would become injuriously heated, and the steam rushing out at the aperture would cause the fire to be extinguished. The tubes E, which serve to conduct the flame through the boiler to the smoke box, are made of the best rolled brass, $\frac{1}{16}$th of an inch thick, and $1\frac{5}{8}$ of an inch in external diameter; they are 124 in number, and the distance between tube and tube is $\frac{5}{8}$ of an inch. The tubes act as stays, connecting the ends of the boiler to strengthen them; but besides these there are rods of wrought iron, represented at *o*, fig. 3, which extend from end to end of the boiler, above the roof of the fire box. The smoke box F, containing the cylinders, steam pipe, and blast pipe, is 4 feet wide, and 2 feet long; it is formed of wrought-iron plates, riveted in the same manner as those of the fire box From the top of the smoke box, which, like the fire box, is semi-cylindrical, rises the chimney G, 15 inches diameter, made of $\frac{1}{4}$-inch iron plates, riveted and bound round by hoops. Near the bottom of the smoke box the working cylinders are placed side by side, in a horizontal position, with the slide valves upwards, as seen in fig. 4.

At the top of the external fire box, fig. 3, a circular aperture is formed 15 inches in diameter; and upon this aperture is placed the steam dome, T, 2 feet in height, and secured to the aperture by nuts. The steam dome is made of brass nearly half an inch thick. A funnel-shaped tube *d*, with its wide end upwards, is flanged upon the side of the great steam pipe S, and is carried upwards so that its mouth is near the top of the steam dome T. In order to pass into the steam pipe S, the steam which fills the upper part of the boiler A must ascend into the steam dome and enter the funnel *d*, as indicated by the bent arrow in fig. 3. This arrangement prevents, in a great degree, the effect of *priming*, by which word is expressed technically the spray of water which rises from the water of the boiler, and is mixed with steam in the upper part of it: as the steam ascends into the steam dome this spray falls back, and nothing but pure steam enters the funnel *d*., The wider part of the great steam pipe S is flanged, and screwed at the hinder end to a corresponding aperture in the back of the fire box, where the engineer stands; this opening is covered by a circular plate, secured by screws, having a stuffing box in its centre, of the kind used for the piston rods of steam cylinders. Through this stuffing box the spindle or rod *a'* of the regulator passes; and to its end is attached a winch *h*, by which the spindle *a'* is capable of being turned. To the other end of this spindle at *e* is attached a plate, which moves upon apertures formed in the cover of the end of the great steam pipe S; so that, by turning the winch *h* more or less, this plate *e* may be removed more or less from over the openings; and thus the steam may be allowed to enter the steam pipe S from the steam dome T in greater or less quantity, or may be shut off altogether. The steam pipe S being enclosed within the boiler, is maintained at the same temperature as the steam in the boiler; and therefore the steam, in passing through it, is

not liable to condensation. The steam pipe, passing through the tube plate at the front of the boiler, is turned down at right angles in the smoke box, where it is divided into two branches, one being conducted to each of the valve boxes of the cylinders. The lower ends of these branches are flanged to the valve boxes at the ends of the cylinders nearest to the boiler: by these pipes the steam is conducted into the valve boxes, or steam chests, from which it is admitted by slide valves to the cylinders to work the pistons On the upper sides of the cylinders are the valve chests U, communicating with the passage *m*, fig. 4, leading to the back of the cylinder, *n* leading to the front, and *o* leading through the side pipe P′ to the blast pipe. These openings are governed by a slide, so that, when steam is admitted through *m*, the communication shall be opened between *n* and *o*. Thus, when steam is admitted to the back of the cylinder, the steam from the front will flow from *n*, through *o*, into the blast pipe. When the piston reaches the front of the cylinder, then the slide opens a communication between *n* and the steam pipe, and between *m* and *o*. Thus steam will be admitted to the front of the cylinder, while the steam from the back will escape from *m*, through *o*, to the blast pipe. In this way, by the alternate shifting of the slide, steam is admitted alternately to each end of the cylinder, and allowed to escape from the other end, and the alternate motion of the piston in the cylinder is thereby maintained. The pistons used in locomotive engines are of the kind called metallic pistons, and, from their horizontal position, they have a tendency to wear unequally in the cylinders, their weight pressing them on one side only; but, from their small size, this effect is found to be imperceptible in practice. The cross pipe P′, which communicates with the eduction passage *o*, in each of the valve boxes, has an opening in the centre presented upwards, as seen in fig. 4. To this opening is flanged the base of the blast pipe P, fig. 3, which rises in a direction slightly curved, and has its mouth presented upwards in the centre of the chimney G. The steam which is discharged at each stroke of the pistons from the cylinders passes through this pipe, and up the chimney by puffs. When an is moving slowly, these puffs are distinctly audible, resembling the coughing of a horse; but when at full speed, they succeed each other so rapidly that the ear can scarcely distinguish their intervals. This stream of waste steam, continually rushing up the chimney, maintains the necessary draught in the fireplace; the upper current thus produced in the funnel s a corresponding current into the smoke box F, through the tubes E; and there is this excellence in the arrangement, that the force of the draught in the chimney, being proportional to the quantity of steam produced, must be therefore proportional to the quantity of fuel necessary to be consumed.

The force of the steam thus impressed upon the pistons is communicated by the piston rods Y, fig. 3, the cross heads of which move in guides, to the connecting rods B, which are attached to the crank pins of the working axle C; so that, as the piston rods are driven backwards and forwards in the cylinders, the working axle is made to revolve. This axle has the driving wheels of the locomotive fixed upon it, and the engine is impelled forward upon the railway as the wheels revolve.

The method by which the slides are made to govern the admission and escape of the steam to and from the cylinders is nearly the same as in the steam engine used for the general purposes of manufacture; and for a general description of the method, see STEAM ENGINE. Meanwhile, it may be here briefly stated, that this is effected by two circular plates called *eccentrics*, fixed at E E, fig. 4, on the great working axle. These eccentrics are circular plates or rings, formed upon or attached to the axle so as to revolve in their own plane, forming, in effect, a part of the axle itself; but they are so placed that their centres do not coincide with the centre of the axle, and consequently, as they revolve with the axle, their centres are alternately thrown backwards and forwards, as they pass on the one side or the other of the axle. These circular plates are surrounded by rings, within which they revolve, but which do not revolve with them. These rings are alternately thrown backwards and forwards, by the play of the eccentrics; and to these rings are attached rods *e e*, which communicate motion to the arms which drive the rods of the slides. Thus the alternate motions of the eccentrics backwards and forwards proceed from the working axle, produce a corresponding backward and forward motion in the slides, and thereby govern the admission and escape of the steam to and from the cylinders. When it is required to reverse the motion of the engine, i.e. to make it move backwards, the motion of the slides, and therefore the positions of the eccentrics on the working axle, must be the contrary of that necessary to produce a progressive motion. Sometimes this is effected by shifting the position of the eccentrics on the working axle; but more commonly it is effected by a second pair of eccentrics, represented at F F, fig. 4, placed on the axle in a position contrary to the others. When the engine is driven backwards the eccentrics E E are thrown out of gear, and the eccentrics F F are brought into action.

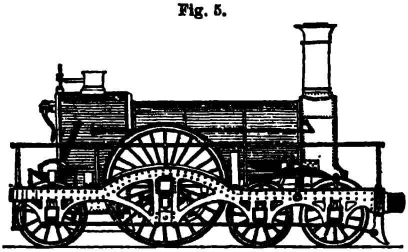
As all the moving parts of the engine require to be constantly lubricated with oil, to diminish the friction and keep them cool, oil cups for this purpose are fixed upon them. In some engines these oil cups are attached separately to all the moving parts: in others they are placed near each other in a row on the side of the boiler, and communicate by small tubes with the several parts to be lubricated.

The tender is a carriage attached behind the engine, and close to it, carrying coke for the supply of the furnace, and a tank containing water for the boiler. The feed for the boiler

is conducted through a curved pipe proceeding from the tank, and carried first downwards, and afterwards in a horizontal direction, as represented at K, fig. 3, under the boiler. It communicates with a forcing pump, which is worked by an arm driven by the cross head of the steam piston. By this pump water is constantly forced into the boiler, so long as the pump is kept in communication with the tank; and this communication may be opened or cut off by a cock *l*, governed by the engineer. As the feed of the boiler by the introduction of cold water checks the activity of the evaporation, it is the custom not to feed the boiler regularly and constantly, but to throw on the feed when the work on the engine is light and the consumption of steam small, and to shut it off when much steam is required. The circumstances of a railway naturally suggest this. When the engine is ascending an incline all the steam which the boiler is capable of producing is required, and therefore the activity of the boiler is stimulated by shutting off the feed; but in descending an incline less power is required, and the feed is put on.

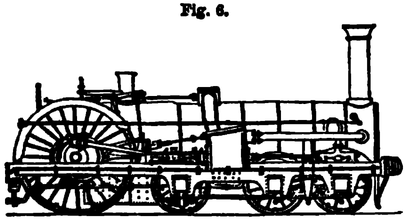
Express Locomotive Engines.—The exigent demand for speed arising out of the competition of the rival gauges and the establishment of express trains, has caused engines of a much more powerful class to be introduced since the first edition of this work was published. Annexed we give examples of this class of engine, being the express engine designed by Mr. Gooch for the Great Western Railway (fig. 5), and Crampton's express engine (fig. 6) applicable to the narrow gauge. These engines were both displayed at the Great Exhibition

Fig. 5.



of 1851. The cylinders of Gooch's engine are each 18 inches in diameter and 24 inches stroke; the driving-wheels are 8 feet in dia-

Fig. 6.



meter; the fire-grate contains 21 square feet of area; the heating surface of the fire box is 153 square feet. There are in all 305 tubes of 2 inches diameter, giving a surface in the tubes of 1,799 square feet: the total heating surface, therefore, is 1,952 square feet. Mr. Gooch states that an engine of this class will evaporate from 300 to 360 cubic feet of water in the hour, and will convey a load of 236 tons at a speed of 40 miles an hour, or a load of 181 tons at a speed of 60 miles an hour. The weight of this engine empty is 31 tons; of the tender 8½ tons; and the total weight of the engine when loaded is 50 tons.

Traction on Roads and Railways.—The tractive force requisite for drawing carriages over well-formed and level common roads is about 1-36th of the load at low speeds. The tractive force requisite for drawing carriages upon railways is about 1-300th of the load, or about 7½ lbs. per ton at low speeds; but in the case of very well formed railways the force necessary for traction is less than this. The resistance, however, increases very rapidly with the speed of the train; and Mr. Gooch has ascertained experimentally that it requires a power of 1,018 horses to be developed in the cylinders to give to a train weighing 149½ tons a speed of 61·3 miles an hour. Of this power 796 horses are expended in propelling the train, and the residue is expended in overcoming the resistance of the blast-pipe, or, in other words, in blowing the fire. The evaporative power of a locomotive boiler varies as the fourth root of the speed.

Locomotive Power. This term denotes, in contradistinction to stationary power, any kind of moving power applied to the transport of loads on land, and travelling with the load which it draws. Horses employed to draw carriages or carry loads are locomotive powers. [LOCOMOTIVE ENGINE.]

Loculicidal (a word coined from the Lat. loculus, *a cell*, and cieo, *to move*). In Botany, that mode of dehiscence which consists in the ripened carpels splitting through their backs.

Loculus (Lat.). In Botany, a cell or cavity. The term is usually applied to the cells of the ovary.

Locum Tenens (Lat. *holding a place*). A term denoting a deputy or substitute; the French form of the phrase is LIEUTENANT [which see].

Locus (Lat. *place*). In Ancient Geometry, a line, right or curved, every point of which satisfies given conditions. [LOCAL PROBLEM.] Thus the locus of a point equidistant from two given fixed points A and B is the right line which bisects AB perpendicularly.

When the locus of the variable point was a straight line or a circle, it was called by the ancient geometers a *plane locus*; and when it was one of the conic sections, a *solid locus*.

Plane loci formed a branch of the ancient analysis which, according to the account of Pappus, was treated of by Apollonius in two books which have been lost. They were partly restored by Schooten, a Dutch geometer, who flourished in the seventeenth century, and by Fermat; but afterwards in a complete manner by Dr. Simson of Glasgow, whose

treatise *De Locis Planis*, published in 1749, is a model of geometrical elegance. The principal propositions may be found in Leslie's *Geometrical Analysis*.

In Modern Geometry, the term *locus* is used more generally, to indicate, not only the curve described by a variable point, but also the surface generated by a variable curve. Thus the locus of a right line which rests upon three fixed right lines, not in the same plane, is a hyperboloid of one sheet. Envelopes, again, may be regarded as the loci of their CHARACTERISTICS [which see].

The *locus of an equation*, in algebraic geometry, is the curve or surface upon which are situated all the points whose coordinates satisfy that equation. In this manner, loci are distinguished into *orders*; the order of a locus being simply the degree of the corresponding equation.

Locust (Lat. locusta). The common name of a species of insects, forming a group or subgenus of the *Gryllus* of Linnæus. They have coloured elytra, and large wings, disposed when at rest in straight fan-like folds, as in other *Orthoptera*, and frequently exhibiting bright blue, green, or red colours. The thorax is capacious, to afford room for the powerful muscles of the wings, and is marked in many species with one or more crests or wart-like prominences. The locusts fly by starts, but frequently rise to a considerable height. Certain species, called *migratory locusts*, unite in incalculable numbers, and emigrate, resembling in their passage through the air a dense cloud: wherever they alight, all signs of vegetation quickly disappear, and cultivated grounds are left a desert. But the mischief does not end here; for when dead, the mass of decomposing bodies is so great that the air becomes poisoned by the fetid exhalations. The second chapter of Joel gives a powerful description of the devastation committed by these destructive insects.

M. Miot, in his translation of Herodotus, has given it as his opinion, that the heaps of bodies of winged serpents which that historian states that he saw in Egypt, were nothing more than masses of this species of locust. These insects are eaten in various parts of Africa, where the inhabitants collect them both for home consumption and for commerce. They take away their elytra and wings, and preserve them in brine. One species (*Acridium migratorium*, Latr.) occasionally commits devastations in the south of Europe and Poland; and stragglers have occasionally reached our own coasts. In the United States, the term *locust* is applied to a species of *Cicada*, which by their numbers and voracity are almost as destructive as the true locusts of the Old World.

Locust-tree. The *Ceratonia Siliqua*. The name is also sometimes applied to the *Robinia Pseud-Acacia*.

Locusta (Lat.). In Botany, a term applied to that form of spike which consists of flowers destitute of calyx and corolla, the place of which is occupied by bracts, and has a flexuose rachis that does not fall with the flowers. The grasses afford examples. Each part of the inflorescence so arranged is called a *locusta*, the structure of which is as follows: at the base are two opposite empty bracts called *glumes*, one of which is attached to the rachis a little above the base of the other; above the glumes are several florets sitting in denticulations of the rachis; each of these consists of one bract called a *pale*, sometimes with the midrib quitting the lamina a little below the apex, and elongated into a bristle; and of another bract facing the first, with its back to the rachis, bifid at the apex, with no dorsal vein, but with its edges inflexed, and a rib on each side at the line of inflexion; and, lastly, within these pales are situated two extremely minute fleshy scales (*lodicula*), which are sometimes connate, and stand at the base of the sexual organs.

Lode (A.-Sax. lædan, *to lead*). The technical Mining term for a metalliferous or ore-producing mineral vein. In mining districts ore occurs either in mineral veins or in beds. If in the former, the veins are almost invariably found to have one of two or three principal directions, being either nearly parallel to the axis of elevation of the district, at right angles to that direction, or making an angle of 45° with it. The first series are generally called by miners *right-running veins* or *lodes*; the second are *cross courses*; and the third *contra lodes*, sometimes called *caunters*. Lodes differ almost without limit, in length, width, and depth, and also in the nature of their mineral contents. [MINERAL VEINS.]

Lodesman (A.-Sax. lád-man, *a leader*). A pilot for harbour and river duty.

Lodestar (Icelandic leidar-stierna, *leading star*). A name for the pole star.

Lodestone. The name given to magnetic iron-ore when endowed with magnetic polarity; in which case it constitutes the native magnet or lodestone. [MAGNETITE.]

Lodge. [FREEMASONRY.]

Lodgement (Fr. logement). In Fortification, an intrenchment hastily thrown up on a captured breach or outwork, in order to maintain the position against recapture.

Lodicula. In Botany, a term given by Palisot de Beauvois to the two minute colourless fleshy hypogynous scales which are situated beneath the ovary of grasses.

Lodoicea. The Coco de Mer or Double Cocoa-nut, *L. Sechellarum*, belongs to this genus of palms, which is found only in the Seychelles, and is there so rare as to have been in danger of extinction through the reprehensible practice of cutting down the trees for the sake of the nuts. These great hard black two-lobed nuts are very singular objects. The trunk is set in a very curious socket-like case.

Loess. A local deposit of fluviatite origin, consisting of a finely comminuted sand or powdery loam of yellowish grey colour. This sand is chiefly argillaceous matter, with about fifteen per cent. of carbonate of lime and as much quartzose or micaceous sand. It often contains hard calcareous concretions in parallel

It is unsolidified, and easily washed away. It contains land shells, and sometimes freshwater species. *Succinea elongata* is characteristic of it. It rarely shows signs of stratification, being perfectly homogeneous. It chiefly occupies the valley of the Rhine, and is newer than any regularly deposited rock in the district. It is sometimes seventy feet thick. Near Bâle it caps hills 1,200 feet above the sea.

Log, Log-line. In Sea language, the log is a piece of wood, in the form of a sector of a circle (usually a quadrant) of five or six inches radius. It is about a quarter of an inch thick; and so balanced, by means of a plate of lead nailed to the circular part, as to swim perpendicularly in the water, with about two-thirds immersed under the surface. The log-line is a small cord, one end of which is fastened to the log, while the other is wound round a reel in the stern part of the ship. The log thus poised keeps, in theory, its place in the water, while the line is unwound from the reel as the ship moves through the water; and the length of line unwound in a given time gives the rate of the ship's sailing. This is calculated by *knots* made on the line at certain distances, while the time is measured by a sand-glass of a certain number of seconds. In order to avoid calculation, the length between the knots is so proportioned to the time of the glass that the number of knots unwound while the glass runs down shows the number of miles the ship is sailing per hour. Thus, suppose the glass to be a half-minute one, it will run down 120 times in an hour. Now, distances by sea are reckoned by nautical miles of 60 to a degree; so that each mile contains about 6,100 feet, the 120th part of which is about 51 feet. If, therefore, the knots (which are pieces of coloured cloth) are fastened to the log-line at distances of 51 feet, the number of knots unwound from the reel in half a minute is the number of miles the ship runs in one hour. If the glass runs down in less than half a minute, the intervals between the knots must be diminished in proportion. The first knot is placed about five fathoms from the log, to allow the latter to get clear of the ship before the reckoning commences; and the part of the line between the lead and the first knot is called the *stray-line*. The action of the log is uncertain, currents and other contingencies affecting it. More complicated logs are often used, which themselves register the rate, direction, &c. The log is heaved hourly in men-of-war, and every two hours in merchant-vessels, the particulars being each time entered in the ship's log-book.

Logan Stones or Rocking Stones. The name given in Cornwall and elsewhere to blocks of stone so exactly balanced on three points of the solid rock below, that a slight effort will move them, although their weight may amount to many tons. These are probably natural, and may have been either dropped by ice that has floated over or moved upon the surface during the glacial period, or so shaped by the effect of weathering.

Loganiaceæ (Logania, one of the genera). An important natural order of perigynous Exogens, belonging to the Gentianal alliance; in which it is distinguished by having opposite leaves and intervening stipules. The order is mostly tropical, and includes several genera, the most important of which is *Strychnos*, which contains the Poison Nut, *S. nux vomica*; the Tieuté, *S. Tieuté*; the Woorali, *S. toxifera*; and the Clearing Nut, *S. potatorum*. The *Spigelias* and *Potatias* are also active plants. *Strychnos pseudoquina* is, however, said to be the best febrifuge in Brazil.

Loganite. A hydrated silicate of alumina, magnesia, and protoxide of iron, occurring in the Laurentian limestones of Canada, and named after Sir W. E. Logan.

Logarithm (Gr. λόγος, *a proportion*, and ἀριθμός, *number*). Every number may be regarded as a power of another given invariable number or *base*. The exponent of that power is said to be the *logarithm of the number to that base*. Thus 10 being the base, the logarithm of 1,000 is 3, and generally if $n=a^x$, x is the logarithm of the number n to the base a, or symbolically $x=\log_a n$. Since $1=a^0$ and $a=a^1$, we at once conclude that the logarithm of 1 is 0 in every system of logarithms, and that 1 is always the logarithm of the base itself. If x_1, x_2, be the respective logarithms of any two numbers n_1, n_2, and a the base of the system, we have by definition

$$n_1=a^{x_1},\ n_2=a^{x_2},$$

and hence

$$n_1\,n_2=a^{x_1+x_2}$$

whence

$$x_1+x_2=\log_a(n_1n_2),$$

that is to say (1) the logarithm of the product of two or more numbers is always equal to the sum of their logarithms; similarly, since

$$\frac{n_1}{n_2}=a^{x_1-x_2},$$

it follows that (2) the logarithm of the quotient is the excess of the logarithm of the dividend over that of the divisor. Lastly, since $n_1{}^m=a^{mx_1}$, whether m be integral or fractional, we conclude that (3) the logarithm of any power of a number is the product of the logarithm of the number and the exponent of the power, and (4) the logarithm of any root of a number is obtained by dividing the logarithm of the number by the index of the root.

By means of a calculated table of logarithms, therefore, the operations of multiplication, division, involution, and evolution, may be replaced by the simpler operations of addition, subtraction, multiplication, and division. Hence the great utility of logarithms in numerical computations. The system of logarithms in general use is that known as Briggs's system, which corresponds to the base 10. The advantages of the system will be manifest on observing that the logarithms of any two numbers which differ only in the position of the decimal point, have the same decimal part or *mantissa*, and merely differ in their integral parts or *charac-*

teristics, which latter can be easily supplied, so that the tables need only contain the several mantissæ. Thus,

$$\log 7359 \cdot 4 = \log (10^3 \times 7 \cdot 3594) = 3 + \log 7 \cdot 3594.$$

Now 7·3594 being between 1 and 10, its logarithm will be between 0 and 1, and will consequently have the characteristic 0; it is in fact 0·8668424. Log 7359·4, therefore, will have the same mantissa with the characteristic 3, which is obviously the *number of places to the left of the units place at which significance begins* in the number 7359·4. Again, since

$$\cdot 0073594 = \frac{7 \cdot 3594}{1000},$$

$$\log (0 \cdot 0073594) = 0 \cdot 8668424 - 3.$$

This result, which is in reality negative, is usually written thus $\bar{3}$; 8668424, the mantissa, for obvious reasons, being preserved positive, and the characteristic alone made negative; the latter, it will be observed, indicates that in the number 0·0073594 *significance begins three places to the right of the units place*, whence is manifest the very simple rule for supplying the characteristic of the logarithm. [SIGNIFICANT DIGITS.]

When a table of logarithms has been calculated to any base, logarithms to a different base can be obtained from it by mere multiplication by a constant factor. Thus $e = 2 \cdot 7182818284 \ldots$ being the base of the *natural* or *Napierian* system of logarithms [EXPONENTIAL SERIES], x the natural, and ξ the common logarithm of one and the same number, we shall have the relation $e^x = 10^\xi$, both these quantities being equal to the number in question. Taking the natural logarithms of these equals, we have

$$x = \xi \log_e 10 \text{ or } \xi = \frac{1}{\log_e 10} x.$$

This number

$$\frac{1}{\log_e 10} = 0 \cdot 4342944819,$$

by which natural logarithms must be multiplied in order to obtain common logarithms, is called the *modulus* of the latter system.

A convergent infinite series, by means of which natural logarithms, and hence all others, may be calculated, is,

$$\log\left(\frac{1+x}{1-x}\right) = 2\left\{x + \frac{x^3}{3} + \frac{x^5}{5} + \&c. \ldots\right\};$$

the manner in which it is obtained is explained in all text-books. [EXPONENTIAL SERIES.]

Logarithms were invented by Lord Napier, baron of Merchiston in Scotland; and made known in a work published by him in 1614, under the title *De mirifici Logarithmorum Canonis Constructione.* Henry Briggs, a contemporary of Napier, and professor of geometry in Gresham College, constructed another system, having for its base the number 10, which, corresponding with our system of numeration, is much more convenient for the ordinary purposes of calculation. Briggs calculated the logarithms to 14 places, besides the index, of all numbers between 1 and 20,000, and between 90,000 and 100,000, and published them in his *Arithmetica Logarithmica* in 1624. Arian Vlacq, a native of Holland, computed the logarithms of the numbers from 20,000 to 90,000, and thus completed what had been begun and partly accomplished by Briggs; but he reduced the tables to 10 decimal places. Vlacq's *Arithmetica Logarithmica* was published at Gouda in 1628, and contained the logarithms of all numbers from 1 to 100,000, calculated to 10 decimals; as also the logarithms of the sines, tangents, and secants of every minute of the quadrant. Vlacq afterwards, in 1633, published another most valuable work, his *Trigonometria Artificialis*, containing the logarithmic sines, cosines, tangents, and cotangents for every ten seconds of the quadrant, calculated from the natural sines, &c. of the *Opus Palatinum* of Rheticus. In the same year another work of the same kind, the *Trigonometria Britannica*, was published at Gouda, containing the logarithmic sines and tangents for the 100th part of every degree of the quadrant, together with a table of natural sines, tangents, and secants. These had been computed by Briggs.

Logarithms being of constant use in astronomical and trigonometrical calculations, the tables which have been published are very numerous. The most complete are those of Vlacq, already mentioned, to ten decimals; but they are very scarce, and can with difficulty be procured. There is an edition of them by Vega, 1797, also scarce. Gardener's *Logarithms*, printed in 1742, in 4to., and another edition of them at Avignon in France in 1770, are to seven decimals. Callet's *Logarithms*, in 8vo., like Gardener's, contain the logarithmic sines, &c. for every 10 seconds. Taylor's *Logarithms*, in 4to., and also Baguay's, have them to every second. Hutton's *Logarithms*, and Babbage's *Logarithms of Numbers*, are well known. The latter was carefully collated, and is very accurate and convenient. Hulsse's *Sammlung Mathematischer Tafeln* (second stereotyped edition, Leipzig 1849) is also exceedingly accurate and useful.

The above (excepting Vlacq's and Vega's) are all to seven decimal figures, but for many purposes logarithms to a less number of decimals are sufficiently accurate. For navigation and surveying, tables to six figures are the most convenient, as they give in general the trigonometrical lines correct to single seconds. The best tables of this kind are Farley's *Tables of Six-figure Logarithms* (12mo. 1840). For many auxiliary computations in astronomy, it is sufficient to have the logarithms to five places. The reprint of Lalande's *Five-figure Table* by the Useful Knowledge Society (18mo. 1839) is convenient, and may be relied on for accuracy.

Logarithmic Curve. A curve whose abscissæ are proportional to the logarithms of the corresponding ordinates. It may easily be

constructed from its equation $x=m\log_e y$ or $y=a^x$, where $m=\frac{1}{\log_e a}$ is the modulus of the system of logarithms whose base is a. This modulus is precisely the subtangent $y\frac{dx}{dy}$ at any point of the curve; that is to say the portion of the abscissa axis, of constant length, which is intercepted between the tangent and the ordinate at any point. The curve obviously approaches the abscissa axis asymptotically on the negative side of the origin, and recedes to an infinite distance from it on the positive side; it crosses the ordinate axis at the unit of distance above the origin.

The curve was investigated first by Gregory of St. Vincent, and afterwards by Huygens, Euler, and others. With respect to a controversy which arose as to the proper interpretation of the equation $y=e^x$, see Euler's *Anal. Inf.* vol. ii.; Vincent, in Gergonne's *Annales*, vol. xv.; and Gregory in *Cam. and Dub. Math. Journal*, vol. i.

Logarithmic Spiral. A curve imagined by Descartes, and best defined by its polar equation $r=a^\theta$. It has the property of reproducing itself in various ways; its involute, reciprocal, evolute, inverse, pedal, &c. are all logarithmic spirals, as are also its caustic by reflexion and refraction, the light being incident from the pole. It cuts all its radii vectores at a constant angle whose tangent is the modulus of the system of logarithms, having the base a, i.e. the radius vector, corresponding to the angle $\theta=1$.

Newton proved that if the force of gravitation had been inversely as the *cube* of the distance, instead of the *square*, the planets would have shot off from the sun in logarithmic spirals. (*Principia*, lib. i. prop. ix.)

James Bernoulli's paper on this curve in the *Acta Eruditorum*, 1692, is well worthy of perusal as a fine specimen of mathematical eloquence and enthusiasm.

Logic (Gr. λογική, sc. τέχνη, *art*, from λόγος, *discourse*). Logic has been defined to be the science, and also the art, of reasoning. It is a science, because it investigates those principles on which reason proceeds: it has been termed an art, as furnis rules whereby the formal part of an argument may be constructed. Logic was highly valued, perhaps overvalued, among ancient philosophers. The Stoics, in particular, were celebrated for their application of its principles to their own favourite metaphysical discussions. From the abuse of logical knowledge arose the celebrated fallacies of the Sophists, who, according to the satirical representations of Athenian writers, were hired to furnish their pupils with the means of defending right or wrong positions with equal facility. Zeno of Elea is called the *father of logic*, or dialectics, according to the ancient appellation of the science; but we are not well acquainted with the discipline which he taught; although it can hardly have consisted, as more recent writers have represented, of a mere manual of captious fallacies. But it is to the master mind of Aristotle that the science owes, as far as we are able to ascertain, its first exposition, and its systematic developement. When, in the middle ages, the Aristotelian logic became the foundation of the scholastic philosophy, attempts were made, especially one by the famous Raymond Lullius, to throw the science into a new form, but without success. In consequence of the various misapplications and perversions which the system had undergone in the hands of later dialecticians, it fell into great disrepute in modern times; and many of our first metaphysical writers, as Locke, for example, have treated it with a contempt not wholly undeserved by the ordinary expositions of the nature and objects of the science.

The following sketch gives the outlines of the science, as set forth in Whately's *Elements of Logic*.

However multifarious the subjects to which reasoning may be applied, and however complicated its details may become, the process by which all reasoning is conducted is one and the same. Whoever seeks to prove that because one thing is thus, therefore another thing is so, whether he be a philosopher pursuing a recondite truth, or a labourer commenting on the events of his daily life, cannot travel out of the bounds of Aristotelian syllogism. In analysing the process in question, we find, in the first place, that every truth, or apparent truth, arrived at by reasoning, technically termed *a conclusion*, is deduced from two other propositions, technically termed *premisses*, either both expressed, or one expressed and the other implied. In many instances it is at once evident to the mind of one capable of reasoning that if the two premisses be true, the conclusion must follow. Thus, if I wish to prove the mathematical truth that every A is equal to B, I find a third quantity, C, which is equal to both; and my argument then assumes the following shape: 'Whatever is equal to C is equal to B;' but every A is equal to C, therefore every A is equal to B.' Here the connection between the conclusion and the premisses is at once evident and true; but there are many cases in which there is an apparent connection which is in reality false: in other words, from two premisses a conclusion is deduced, which, admitting the truth of those premisses, does not in reality follow from them. The following, for example, is an instance of a conclusion incorrectly deduced from its premisses, which, nevertheless, might at first sight pass current for reasoning: 'Every rational agent is accountable; brutes are not rational agents, therefore brutes are not accountable.' To explain the reason why the first of these two arguments is sound, and the latter unsound, requires the examination not of truths in mathematics or in natural religion, but simply of the common process of reasoning; and logic affords the means of making such an analytical investigation. The first of these arguments is a correct, the latter a false or apparent, syllo-

gism; and the validity of the first and invalidity of the latter depend upon the necessary or unnecessary connection between the premisses and the conclusion. A single sentence may often be found to contain, elliptically expressed, and compressed into a narrow compass, a whole chain of separate syllogisms; but every single conclusion has been arrived at by this process, and by this only.

The principle of the syllogism is contained in the famous maxim termed in the schools of the middle ages the *dictum de omni et nullo*, viz. that 'whatever is predicated (i.e. affirmed or denied) universally of any class of things, may be predicated, in like manner (i. e. affirmed or denied) of any thing comprehended in that class.' Thus, for example, in the instance previously given of a valid argument, if it can be predicated of the whole class of things which are equal to C that they are also equal to B; if I find any thing equal to C, I may predicate of it that it is equal to B also. Hence my second premiss, A is equal to C, serves to bring me, logically, to the required conclusion—that A is equal to B. This, therefore, is the general principle on which that process is conducted which takes place in every syllogism.

In order that reasoning may be contemplated simply as reasoning, without any reference to the essential truth or falsehood of the propositions contained in it, and also with a view of furnishing brief and expressive forms, like those of algebra, instead of words at length, a set of arbitrary symbols are employed in logic, to denote the quantity and quality, as they are termed, of propositions. Every proposition either affirms or denies a fact; every proposition also predicates (i. e. affirms or denies) that a certain attribute belongs either to a whole class, or to some members of a class, of objects: propositions are therefore, in quality, either affirmative or negative; in quantity, universal or particular. Thus the four symbols of propositions in logical manuals are, A, universal affirmative; I, particular affirmative; E, universal negative; O, particular negative. And the form of a syllogism, according to the character of each of its premisses and of the conclusion, is expressed by three of these letters. Thus the syllogism first given, consisting of three universal affirmatives (for it will be found, on examination, that each proposition predicates a certain attribute of all the members of a class), will be designated by A A A; a syllogism termed in logical language *barbara*. [SYLLOGISM.]

It is also found, on further analysis, that a syllogism embraces three separate objects or notions, two of which are compared with the third, and in consequence of that comparison pronounced to agree or disagree with each other. Thus, in the syllogism, 'No dishonest man is a good citizen: Caius is a dishonest man; therefore Caius is not a good citizen; the individual object, *Caius*, and the class of objects, *good citizens*, being compared with a third class, *dishonest men*, are found, the one to agree, the other to disagree, with that class; and hence it inevitably follows that they disagree with each other—i. e. the conclusion of the syllogism is negative. These three objects, or *terms*, as they are called in logic, occur in every syllogism. The predicate of the conclusion—i. e. that term which, in the conclusion, is predicated of the other, in this instance *good citizen*—is called the *major term*; the subject of the conclusion—i. e. that term of which the other is predicated (Caius)—is the minor term; and the term with which the other two are respectively compared, *dishonest man*, is the middle term.

But every word, or combination of words, is not capable of constituting a term—i. e. something which may be predicated of another thing, or of which another thing may be predicated. In the first place, adverbs, prepositions, nouns in any inflection from the nominative case, &c., can only form parts of a term; in logical phrase, they are syncategorematic: adjectives, also, have always impliedly a nominative subjoined, when employed as terms. Verbs are mixed words, being resolvable into a term employed as a predicate, united to the *copula* or auxiliary verb (*is* or *is not*). Thus, nouns in the nominative case alone are simple terms or categorematics; these, again, are either the name of an individual or the name of the class: the former (singular terms) may be subjects, but cannot be predicates; the latter may be either. Thus, in the proposition 'Crassus is rich,' the singular term *Crassus* is the subject of which it is predicated that he is rich—i. e. a rich man.

A common term, being a word equally applicable to a number of individuals, expresses a notion formed by the faculty of abstraction. When, for example, we contemplate several individual oak trees, and abstract from each its separate peculiarities of height, growth, &c., we form the notion of an oak. Contemplating a number of trees of mixed species, and abstracting from each its specific peculiarities of leaf, fruit, &c., we next arrive at the common notion *tree*. These common notions or terms are then the *predicables* which can be affirmed or denied of other objects.

Predicables are divided into several kinds, although the division, perhaps, appertains in strictness rather to metaphysical than to logical science. Every predicable is said, according to this division, to express either the GENUS, SPECIES, DIFFERENCE, PROPERTY, or ACCIDENT, belonging to an individual. [See these heads, and PREDICABLE.] But it is to be remembered that a predicable may be referred to one or other of these several kinds, according to the point of view from which it is contemplated. If I say of Cæsar that he is a *man*, I express his species, considering him in those respects in which he differs from other animals. If I say that he was *brave*, I express a property. If I predicate of him the several circumstances in which he absolutely differed from all other men, I express

that property or that bundle of united properties which forms his *difference*. Every predicable, with a little attention, may be ranged under one or the other of these five classes.

The popular system of logic thus set forth by Dr. Whately has provoked a series of controversies which at the least serve to show how strong a power the Realism of the schoolmen has retained even over those who profess to regard their theory with contempt. The views of Whately on the subjects of Predication and Syllogism assign to names a mysterious virtue which the Realists attributed to abstract realities; and if this be so, it follows of necessity that he could not have clearly seen the nature or the object of the science which he was striving to promote. To lay bare the errors and defects of this system, not from any desire to win an intellectual victory, but with the simple wish to show that logic is a true science of which the cultivation is not mere waste of time, is the object of Mr. John Stuart Mill's *System of Logic Ratiocinative and Inductive*. These errors, in Mr. Mill's judgment, are to be traced to the belief that the principle of the syllogism is contained in the Aristotelian dictum de omni et nullo, which makes the theory of predication to consist in referring something to a class, i.e. either placing an individual under a class or placing one class under another class, or, in the case of negatives, excluding them from that class. Taken without qualification, this method implies that mankind in the beginning decided on all possible classes, and left to us simply the task of referring everything to its proper class. In refutation of this theory, Mr. Mill remarks that when we say, 'Snow is white,' we think of snow as a class, but not of white objects as a class, and indeed of no other white object except snow and of the sensation of white which is caused by it. 'When I have judged or assented to the propositions that snow is white and that several other things also are white, I gradually begin to think of white objects as a class. But this is a conception which followed, not preceded, those judgments, and therefore cannot be given as an explanation of them. The doctrine, therefore, is founded on a latent misconception of the nature of classification. When it was found that the diamond was combustible, it was referred to a class (of combustibles) to which till then it had not belonged; it was so placed because the proposition is true; the proposition is not true, because the object is placed in the class.' Hence the Aristotelian dictum turns out to be a signal ὕστερον πρότερον, while it is seen that classification is the result of induction applied to the phenomena of nature and to all cognisable facts; and logic, instead of being confined to mere names and formulæ, becomes a science which deals with things as we find them; in other words, with facts. In truth, the dictum de omni et nullo ceased to have any real force when the theory of the Realists was rejected. 'So long as what were termed universals were regarded as a peculiar kind of substances, having an objective existence distinct from the individual objects classed under them, the dictum de omni et nullo conveyed an important meaning. The assertion that the entire nature and properties of the substantia secunda formed part of the properties of each individual substance called by the same name, that the properties of *man*, for example, were properties of *all men*, was a proposition of real significance when *man* did not mean *all men*, but somewhat inherent in men and vastly superior to them in dignity. Now, however, when it is known that a class, a universal, a genus or species, is not an entity per se, but neither more nor less than the individual substances themselves which are placed in the class, and that there is nothing real in the matter except those objects, a common name given to them and common attributes indicated by the name, what do we learn by being told that whatever can be affirmed of a class may be affirmed of every object contained in the class? The class *is* nothing but the objects contained in it; and the dictum de omni merely amounts to the identical proposition, that whatever is true of certain objects is true of each of those objects.' But modern philosophers, who would regard the theory of the Realists with contempt, were still under the spell. 'Once accustomed to consider scientific investigation as essentially consistent in the study of universals, men did not drop this habit of thought when they ceased to regard universals as possessing an independent existence; and even those who went the length of condemning them as mere names could not free themselves from the notion that the investigation of truth consisted, entirely or partly, in some kind of conjuration or juggle with those names.' Logic, then, is not concerned primarily, or necessarily, or chiefly, with universals—the propositions which are so called, being nothing more than general statements jotted down in a note-book for convenience of reference, and having a value only in the measure in which they correctly sum up facts. Hence 'propositions are not assertions respecting our *ideas* of things, but respecting the things themselves,' and 'every proposition which conveys real information asserts a matter of fact, dependent on the laws of nature, and not on artificial classification,' all other propositions being simply verbal, and all syllogisms founded on such propositions being merely verbal also, and about as edifying as the revolutions of a squirrel in its cage. This analysis exhibits, then, as the principle of syllogism, not the unmeaning Aristotelian dictum, 'but a fundamental principle, or rather two principles, strikingly resembling the axioms of mathematics. The first, which is the principle of affirmative syllogisms, is that *things which coexist with the same thing coexist with one another*; the second, the principle of negatives, that *a thing which coexists with another thing with which other a third thing does not coexist, is not coexistent with that third thing*. These axioms manifestly relate to facts, not to conventions; and one or

other of them is the ground of the legitimacy of every argument in which facts and not conventions are the matter treated of.' Unless these statements can be refuted, the superstructure of Whately's system of logic is shattered. Thus, the theory that a common term expresses a notion formed by the faculty of abstraction is at once set aside on the ground that no name can be the result of the process of abstraction, which can but give certain qualities as essential or otherwise to the object to be defined, but which does not imply that any other object of comparison exists. The idea that a syllogism is vicious if there be anything more in the conclusion than was assumed in the premisses, still more completely betrays the misconception which underlies the whole system; for it implies 'that nothing ever was or can be proved by syllogism which was not known or assumed to be known before.' Such a view would further involve the admission that ratiocination is not a process of inference, and that syllogism to which the word *reasoning* has so often been represented to be exclusively appropriate is not really entitled to be called reasoning at all. But logicians who speak thus of the syllogism still insist that it is a process of inference. How, then, is this proved? If we say, 'All men are mortal: this or that living being is a man: therefore he is mortal,' we infer new truth, i.e. a truth not ascertained by actual observation, for the being in question is not yet dead; but how do we infer it? 'Do we in reality conclude it from the proposition, All men are mortal? I answer, No. The error committed is that of overlooking the distinction between the two parts of the process of philosophising, the inferring part and the registering part, and ascribing to the latter the functions of the former. The mistake is that of referring a person to his own notes as the origin of his knowledge. If a person is asked a question, and is at the moment unable to answer it, he may refresh his memory by turning to a memorandum which he carries about with him. But if he be asked how the fact came to his knowledge, he would scarcely answer, because it was set down in his note-book, unless the book was written, like the Koran, with a quill from the wing of the angel Gabriel. How, then, do we know that all men are mortal? From observation of individual cases. From these all general truths must be drawn, and into these they may be again resolved. When, then, we assert that So-and-so yet living is mortal like other men already dead, we may pass through the generalisation, All men are mortal, as an intermediate stage; but it is not in the latter half of the process, the descent from all men to So-and-so, that the inference resides. The inference is finished when we have asserted that all men are mortal. What remains to be performed afterwards is merely deciphering our own notes.' It follows that Whately's assertion that the syllogism is not a peculiar mode of reasoning, is very far indeed from the truth. Far from invariably inferring particulars from universals, 'all inference is from particulars to particulars. General propositions are merely registers of such inferences already made, and short formulæ for making more. The major premiss of a syllogism consequently is a formula of this description, and the conclusion is not an inference drawn *from* the formula, but one drawn *according to* the formula; the real logical antecedent or premisses being the particular facts on which the general proposition was collected by induction.'

To those who may assert that, if this be so, the syllogistic art is useless for the purpose of reasoning, Mr. Mill, admitting that the reasoning lies in the act of generalisation, not in interpreting the record of that act, replies that, 'the syllogistic form is an indispensable collateral security for the correctness of the generalisation itself.' Hence we reach the conclusion that 'the reasoning process is in all cases resolvable into the following elements. Certain individuals have a given attribute: an individual or individuals resemble the former in certain other attributes: therefore they resemble them also in the given attribute. This type of ratiocination does not claim, like the syllogism, to be conclusive from the mere form of the expression; nor can it possibly be so. Whether, for example, from the attributes in which Socrates resembles those men who have heretofore died, it is allowable to infer that he resembles them also in being mortal, is a question of induction, to be decided by the principles or canons which are the tests of the honest performance of that great mental operation.'

Logic, then, far from being concerned only with words or names, is concerned directly with facts. If it be maintained that truths are known to us not only by inference, but also by consciousness or intuition, Mr. Mill replies that with convictions of the latter class logic has nothing whatever to do. 'No science is required for the purpose of establishing such truths; no rules of art can render the knowledge of them more certain than it is in itself. There is no logic for this portion of our knowledge.' Logic, then, 'is not the science of belief, but the science of proof or evidence. In so far as belief professes to be founded on proof, the office of logic is to supply a test for ascertaining whether or not the belief is well grounded.' We are thus brought to a question of paramount importance. 'As all inference, consequently all proof, and all discovery of truths not self-evident, consists of inductions and the interpretation of inductions, as all our knowledge, not intuitive, comes to us exclusively from that source, the main question of the science of logic is the enquiry, What is induction? Although the proposition that the course of nature is uniform, is the fundamental principle of induction, it would yet be a great error to offer this large generalisation as any explanation of the inductive process. On the contrary, it is in itself an instance of induction, and induction by no means of the most obvious kind. Far from

being the first induction we make, it is one of the last, or at all events one of those which are latest, in attaining strict philosophical accuracy.' If, then, logic be a science at all, it can be so only as enabling or helping us to ascertain and understand the phenomena which surround us; but Mr. Mill is careful to add, 'When in the course of this enquiry I speak of the cause of any phenomenon, I do not mean a cause which is not itself a phenomenon. I make no research into the ultimate or logical cause of anything: the causes with which I concern myself are not *efficient* but *physical* causes.' If, then, the Aristotelian syllogism is an admirable security for our reading rightly the records of past generalisations, induction is of even greater importance as enabling us to discover and prove the general proposition on which syllogism is founded; hence 'a complete logic of the sciences would be also a complete logic of practical business and common life.' Induction, then, completely reversing the Aristotelian order in the dictum de omni et nullo, 'is that operation of the mind by which we infer that what we know to be true in a particular case or cases, will be true in all cases which resemble the former in certain assignable respects.' As it is strictly a process of inference from the known to the unknown, any process in which, as in the Aristotelian syllogism, the conclusion is no wider then the premisses from which it is drawn, does not fall within the meaning of the term; and further, as induction is concerned solely with facts, every well-grounded inductive generalisation must be 'either a law of nature or a result of the laws of nature, capable, if those laws are known, of being predicated from them.' Hence it follows that 'the problem of inductive logic may be summed up in two questions: How to ascertain the laws of nature? and how, after having ascertained them, to follow them on to their results?' Mr. Mill lays down five canons to be observed in the task of singling out from among the circumstances which precede or follow a phenomenon, those with which it is really connected by an invariable law.

I. *Method of Agreement.*—If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which all the instances agree is the cause (or effect) of the given phenomenon.

II. *Method of Difference.*—If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common, save one, that one occurring only in the former, the circumstance in which alone the two instances differ, is the effect, or cause, or a necessary part of the cause, of the phenomenon.

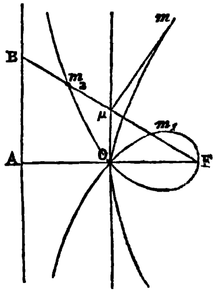
III. *Joint Method of Agreement and Difference.*—If two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance, the circumstance in which alone the two sets of instances differ is the effect, or cause, or a necessary part of the cause of the phenomenon.

IV. *Method of Residues.*—Subduct from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents; and the residue of the phenomenon is the effect of the remaining antecedents.

V. *Method of Concomitant Variations.*—Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon, or is connected with it through some fact of causation.

This brief and imperfect sketch of Mr. Mill's system of logic may serve to show some of the many points in which it is at issue with that of Dr. Whately and his followers, and to indicate the grave nature of the controversies on the limits and functions of the science. (See, further, the treatises of Mansel, Shedden, Kerslake, and Archbishop Thomson.)

Logocyclic Curve (Gr. λόγος, and κύκλος, *a circle*). A name given by Dr. Booth (*Quarterly Journal of Mathematics*, vol. iii.) to a circular cubic, whose properties are intimately connected with those of logarithms. It may be constructed by increasing and diminishing the radii vectores $F\mu$ from a given point F to a given line $O\mu$, by a length $\mu m_1 = \mu m_2$ equal to the distance μO of μ from the perpendicular FO, let fall from the given point F upon the given line $O\mu$. The points m_1, m_2 are obviously inverse points with respect to a circle around F with the constant radius $FO = a$, so that the logocyclic curve is its own inverse. Its polar equation is easily seen to be $r = a(\sec\theta \pm \tan\theta)$, and its Cartesian equation to the same origin and axis $(x^2 + y^2)(2a - x) = a^2x$. The curve has a double point at O, and an asymptote AB, whose distance from F is double that of the given line $O\mu$. The perpendicular μm to any radius vector at the point μ, where the latter cuts the given line, clearly envelopes a parabola having O for its vertex, and F for its focus. If m be the point of contact of μm with this parabola, then the difference between the parabolic arc Om and its protangent $m\mu$ will be the logarithm of the corresponding radius vector Fm_1 or Fm_2. Many other interesting properties of the curve are given in Dr. Booth's paper.



Logography (Gr. λόγος, and γράφω). A system of taking down the words of an orator without having recourse to shorthand, which was put in practice during the French revolution. Twelve or fourteen reporters were seated round a table. Each had a long slip of paper, numbered. The writer of No. 1 took down the

first three or four words, and as soon as they were spoken gave notice to his neighbour by touching his elbow, or some other sign; No. 2 passed the sign to No. 3, and so on, until the first line of each slip was filled; No. 1 then began the second line: thus all the twelve or fourteen slips, when filled, being arranged parallel to each other, formed a single page. This mode required great attention and quickness, and was not found to answer well in practice. It was introduced in the National Assembly in October, 1790, the expenses being paid by the civil list; and continued until August 10, 1792, when Louis XVI. and his family, taking refuge from insurrection in the assembly, occupied the box of the logographers. After that time it was not used. (*Dictionnaire de la Conversation.*)

LOGOGRAPHY, LOGOTYPES. [LIGATURES.]

Logogriph (Gr. λόγος, and γρῖφος, *a riddle*). A species of riddle in vogue among the French (whose language is peculiarly adapted to it), in which the original word (whole) is to be discovered by guesses at other combinations of letters included in it. Thus, the word *plate* includes the various combinations tale, teal, pate, peat, peal, pale, leap, &c.

Logwood. The wood of the *Hæmatoxylon campechianum*, a tree growing in many parts of the West Indies and on the adjoining continent. It is employed in dyeing and calico-printing for the production of reds, blacks, drabs, and several compound colours. Its colouring principle has been termed *hæmatine*. An extract of logwood is used in medicine as an astringent. [HÆMATOXYLON.]

Loimic (Gr. λοιμικός, *pestilential*). Relating to the plague or contagious disorders.

Lok or **Loki.** In Northern Mythology, the name of a malevolent deity; corresponding to the Ahriman of the Persians, who is represented to be at war with both gods and men, and originating all the evil with which the universe is desolated. In the *Edda* (the great poem of the Norwegian nations) he is described as the great serpent which encircles the earth, and as having given birth to Hela, or Death, the queen of the infernal regions. [VRITRA.]

Loligo. The squid, or sea-pen cuttle fish; commonly found on our coasts. [SEPIADÆ.]

Lölingite. A name given to Leucopyrite, after one of its localities, Löling in Carinthia.

Lolium (Lat.). A genus of grasses, comprising, along with *L. perenne* and *L. italicum*, which are two of our best pasture and fodder grasses, one of the few deleterious grasses, *L. temulentum*, or Darnel, the seeds of which, ground up with corn, and eaten, produce poisonous effects.

Lollards. A class of persons in Germany and the Netherlands who professed, in the fourteenth century, to undertake spiritual offices in behalf of the sick and dead, and succeeded in attracting the attention and love of the mass of the people when they were in a great measure alienated from the secular and regular clergy by their general indifference and neglect. The origin of the name has been much disputed; but the enquiries of Mosheim seem to show that it is compounded of the German words *lallen* (identical with the *lallare* of the Romans and the *lull* of our own language, signifying to sing in a murmuring strain) and *hard*, a common affix, as in the somewhat similar word *beghard*. A Lollard, therefore, meant one in the habit of singing the praises of God, or funeral dirges and the like. The Lollards, however, were accused—probably through the spite of the mendicant friars and others whose neglected duties they zealously performed—of holding many heretical opinions. Their reforming views may have been violent; but the charges made against them of vicious habits appear to rest upon no authentic grounds. The term was afterwards applied by the partisans of the church to the heretics and schismatics of the day generally; and the followers of Wicliffe in England are frequently stigmatised under the name of Lollards.

Lombard. A term anciently used in England for a banker or money-lender. The name is derived from the Italian merchants, the great usurers or money-lenders of the middle ages, principally from the cities of Lombardy, who are said to have settled in London in the middle of the thirteenth century, and to have taken up their residence in a street in the city which still bears their name. Stowe, in his *Survey of London*, says, 'Then have ye Lombarde Street, so called of the Longobards and other merchants, strangers of diverse nations, assembling there twice every day. The meeting of which merchants there continued until December 22, in the year 1568; on the which day the said merchants began to make their meetings at the Bursse, a place then new builded for that purpose, in the ward of Cornhill, and was since, by her majesty Queen Elizabeth, named the Royal Exchange.' (P. 202.)

Lomentum (Lat.). In Botany, a fruit similar to a legume, excepting that it is contracted in the spaces between each seed, and there separates into distinct pieces; or is indehiscent, but divided by internal spurious dissepiments, whence it appears at maturity to consist of many articulations and divisions. It occurs in the genera *Ornithopus*, *Hedysarum*, &c.

Lonchidite (Gr. λόγχη, *a spear*). A variety of Iron Pyrites, found in small thin tin-white crystals.

London Clay. The name commonly given to a part of the older tertiary deposits of the neighbourhood of London, occupying a kind of trough-shaped depression between the chalk hills of Hertfordshire and Surrey. From the researches of Mr. Prestwich it is clear that the London tertiaries may with advantage be regarded as a distinct group, forming the lower member of the Eocene or lower tertiary series. The whole group contains at least 500 species of organic remains, of which nearly four-fifths are peculiar and characteristic. It underlies the *Bracklesham series* in England, and the *Calcaire grossier* series of Paris.

The London clay, one of the most important members of this group, is persistent over a large area, and everywhere maintains throughout its mass a nearly uniform mineral character. It is not unconformable with the overlying beds, but does not pass into them. It is thickest in Kent and Essex, and becomes thinner towards the west and south-west. Its beds are remarkably rich in various kinds of fossils, including some birds, many reptilian species, and more than fifty determined species of fishes, of which a large proportion are *Ganoid* species. It also contains a rich variety of fossil fruits of a sub-tropical character. The greatest thickness of clay is in Sheppey, where it amounts to 480 feet. The beds of the plastic clay underlie the London clay.

Long. A musical character of this form , the length of which in common time is equal to four semibreves or eight minims.

Long Boat. A large and strong boat, formerly the largest carried by a ship; but it has now generally given place to the launch.

Long Primer. In Printing, the name of a kind of type two sizes larger than that used in this work. [TYPE.]

Long-timbers. In Shipbuilding, those timbers in the cantbodies which rising from the dead-wood are continued in one piece to the top of the second futtocks.

Longan (its native Chinese name). The fruit of *Nephelium Longanum.*

Longicorns (Lat. longus, *long*; cornu, *a horn*). The fourth tribe of Coleopterous insects in the system of Latreille; so called on account of the length of the antennæ, which are rarely shorter than the body, and commonly surpass it in length. But this conspicuous character is not the only one which the Longicorn beetles possess in common. In all of them the under part of the three first joints of the tarsi is furnished with a brush; the second and third are cordiform; the fourth is deeply bilobate; and there is a little nodule, resembling a joint, at the base of the last. The *ligula*, placed on a short and transversal *mentum*, is usually membranous, cordiform, emarginate, or bifid; but sometimes is corneous, and forms the segment of a very short and transverse circle. The antennæ are either filiform or setaceous: they are sometimes simple in both sexes, and sometimes serrate, pectinate, or flabelliform in the males. The eyes in some species are rounded and entire, or but slightly emarginate, and in these species the thorax is trapezoidal or narrowed anteriorly; but in most of the Longicorns the eyes are reniform and surround the base of the antennæ.

As the larvæ of a very great proportion of the Longicorns live in the interior of trees, or under their bark, they are destitute of feet, or have but very small ones. Their body is soft, whitish, thickest anteriorly; and the head squamous, and provided with stout mandibles. They do much injury to trees, the large ones particularly, perforating them very deeply, and sometimes drilling them in every direction. Some of them attack the roots of plants.

The abdomen of the female Longicorns is terminated by a tubular and horny ovipositor. These insects produce a small sharp sound, by rubbing the pedicle of the base of their abdomen against the interior of the parietes of the thorax.

Longipalps. The name of a family of Brachelytrous Coleopterans, or short-winged beetles, which have the maxillary feelers almost as long as the head.

Longipennates (Lat. longus, and penna, *a wing*). A family of swimming birds, comprehending those in which the wings reach as far as or beyond the tail; as the tropic bird, albatross, &c. They are all denizens of the high seas, and from their powers of flight are to be met with in various latitudes. The hind toe is free or wanting. The beak is hooked or pointed at the tip.

Longirosters (Lat. longus, and rostrum, *a beak*). The name of a tribe of Grallæ, or wading birds, including those in which the beak is remarkable for its length and tenuity, and by the high sensibility of its tip is well adapted for searching or probing in mud or sand for worms or insects. The different gradations in the form of the bill serve to divide the Longirosters into families and genera.

Longissimus Dorsi. A muscle of the back, which assists others in keeping the spinal column erect.

Longitude (Lat. longitudo). In Astronomy, this term has two different significations, as it is applied to a celestial or a terrestrial object. The longitude of a heavenly body is the arc of the *ecliptic* intercepted between the vernal equinox and a great circle perpendicular to the ecliptic passing through the body. It is reckoned eastward all round the sphere, from 0° to 360°. The longitude and latitude of a celestial object, having reference to the ecliptic, and not to the plane of the earth's diurnal motion, cannot be directly observed. The elements necessary for determining the place of a star, which are given directly by observation, are its right ascension and declination, from which the longitude and latitude must be calculated by the rules of spherical trigonometry. In the planetary theory, however, it is convenient to refer the motion of a planet to the plane of the earth's orbit, or to make the longitude and latitude the coordinates of its motion. But the places of the stars are always defined, by modern astronomers, by means of their right ascensions and declinations.

The longitude of a place on the earth is the arc of the *equator* intercepted between the meridian of the place and some conventional fixed meridian, which is regarded as the origin from which the measures are reckoned. Terrestrial longitudes and latitudes correspond to right ascensions and declinations in the heavens: with this distinction, however, that the right ascensions are always reckoned from the vernal equinox, or point in which the equator intersects the ecliptic easterly from 0° to 360°; whereas the longitudes are reckoned by different

geographers from different points, selected for some local reason, there being nothing connected with the earth's diurnal rotation which can render one point of the equator more convenient than another. Right ascensions are also reckoned in the same direction (eastward) round the complete circumference; while geographical longitudes are reckoned both eastward and westward, 180° each way.

The parallels of latitude on the earth are distinctly marked out by the diurnal circles described by the stars, and consequently latitude can always be determined by direct observation of the heavens; but the case is entirely different with respect to longitude; for to observers situated under the same parallel of latitude, but under different meridians, the heavens present exactly the same aspect, and there is nothing whatever to indicate any difference of locality. Longitude, therefore, cannot be measured by direct observation; it can only be inferred from the measurement of intervals of time to which it is proportional. In the course of a sidereal day the rotation of the earth brings successively every different meridian under the same star; and, the rotation of the earth being perfectly uniform, it follows that the angular distance of any two meridians will be the same part of 360° that the interval of time which elapses between their coming to the same star is of twenty-four hours. For example, if a star pass the meridian of a place A at a certain moment, and that of B exactly one hour of sidereal time later; then the difference of longitude between A and B is the twenty-fourth part of 360°, or 15°, and the longitude of B is 15° west of A. The determination of longitudes consequently resolves itself into the measurement of time; and as the time, or the instant of mean noon, at any place can always be found without difficulty, if any observer at one place can by any means determine the precise hour it is at any other place *at the same instant*, he has then determined the difference of longitude between the two places. Of the various methods by which differences of longitude may be determined, the simplest and most obvious is that of transferring chronometers from one place to another. Suppose two observers, at the distant stations A and B, each to regulate his clock according to the true sidereal time of his station; and suppose a chronometer, also regulated to true sidereal time, to be compared with the clock at A, and then transported, without suffering any change of rate, to B—the difference of the two clocks would thus be exhibited; and this difference is exactly the time occupied by the equinoctial point, or by any star in passing from the meridian of A to that of B; or it is the difference of longitude of the two places expressed in sidereal hours, minutes, and seconds. Were chronometers perfect, nothing more complete and convenient could be desired; but this unfortunately is even now very far from being the case, and until within a comparatively very recent time the practical determination of the longitude by means of chronometers could not be attempted.

Another method of determining the difference of longitude between two places, is by telegraphic signals. This method, though, from its nature, of limited application, is susceptible of great accuracy. The explosion of a rocket, the flash of gunpowder in an open dish, the extinction of a bright light, &c., are instantaneous phenomena which can be seen at great distances and noted with the utmost precision. A signal of this kind, made at a station visible from two observatories, must be seen at the same absolute instant of time from both; and the time marked by the clock of each observatory at this instant being noted, the difference of their local times, and consequently the difference of their longitudes, becomes known. This method is chiefly practised in connection with geodetical operations for measuring degrees of longitude on the earth's surface, and is perhaps the best that can be adopted for determining the difference of longitude between two observatories situated at no very great distance from each other. By means of intermediate signals, and observers suitably disposed between each, it may also be applied to transfer the time from one place to another, when the distance is too great to allow an artificial signal of any kind to be seen from both. (*Phil. Trans.* 1826.)

When the distance between two places is very considerable, artificial signals cannot be employed, and it becomes necessary to have recourse to the methods furnished by astronomy. These are principally the following:—

1. *Eclipses of Jupiter's Satellites.*—These phenomena are visible at the same instant of absolute time to all places on the earth; and although they are not susceptible of being observed with rigid exactness, this method is much used by travellers, though for fixed observatories the mean of a long series should be taken. The uncertainty is least in the case of the first satellite, on account of its quick motion; and as the eclipses of this satellite occur much more frequently than those of the others, the observations are chiefly confined to it. The times of the eclipses of the three first satellites are given in the *Nautical Almanac*; so that an observer at any part of the world, who observes one of these eclipses, has only to compare his local time with that assigned to the phenomenon in the almanac in order to determine the distance of his meridian from that of Greenwich.

2. *Occultations of Fixed Stars by the Moon.*—This method consists in observing accurately the time at which a certain fixed star disappears behind the disc of the moon, or reappears after having been occulted. The first of these phenomena is called the *immersion* of the star, the second the *emersion*. But, on account of the moon's parallax, the immersion or emersion of a star behind her disc does not take place at the same absolute instant to observers on different parts of the earth; a calculation is therefore necessary to clear the obser-

vation of parallax, or to determine the time at which the phenomenon would have occurred if it had been seen from the centre of the earth. The length of the calculations by which the longitude is deduced is a disadvantage which attaches to this method. [OCCULTATION.]

3. *Eclipses of the Sun.*—The longitude is deduced from the observation of solar eclipses, in the same manner, and by precisely the same sort of calculations, as from the occultation of fixed stars. An eclipse of the sun is, in fact, an occultation; but these phenomena occur so seldom at any particular place, that they afford little assistance in the determination of longitudes. It may be remarked that the irregularities of the border of the moon's disc render the instant of the commencement or end of a solar eclipse, as also of the immersion or emersion of a fixed star, somewhat uncertain. But this uncertainty is corrected, or rather avoided, by measuring with a micrometer the distance between the two cusps, which, shortly after the commencement of the eclipse, appear as brilliant points, sharp and well defined. Knowing the distance of the cusps, or length of the chord, and also the semidiameters of the two bodies, the true distance of their centres at the instant the measure was taken can be calculated without much difficulty. As this measurement can be executed with much precision, and can also be repeated frequently during the progress of the eclipse, the phenomenon of a solar eclipse affords one of the most certain methods of determining a longitude which can be practised. [ECLIPSE.]

4. *Transits of the Moon.*—This method is founded on the moon's rapid change of place among the stars, which becomes very sensible even in short intervals of time. Suppose an observer at the station A to determine the sidereal time of the transit of the moon's centre over his meridian; and suppose another observer at B, to the west of A, also to denote the sidereal time of the same transit; if the moon's right ascension had in the interval undergone no change, the sidereal times marked by the two observers would have been the same; but as the right ascension has increased, while the moon was passing from the meridian of A to that of B, the sidereal time of the transit at the latter place will be increased; and, supposing the change of right ascension to be uniform, the difference of the times of transit will be proportional to the difference of meridians. The chief objection to this method is, that any minute error in the adjustment of the transit instrument or rate of the clock is thrown upon the longitude, on which it produces a very sensible effect. The method can, therefore, only be safely practised at fixed observatories with the best instruments.

5. *Moon-culminating Stars.*—This method has been proposed for the sake of eluding the effect of minute instrumental errors, which render the method last described so difficult. A star is chosen which *culminates* (that is, comes to the meridian) at nearly the same time with the moon, and which has very nearly the same declination; so that it may be seen in the field of view without altering the position of the transit instrument. The transit of the star, as well as the transit of the moon's limb, is observed at both stations (or at least observed at the one station, and calculated for the other whose meridian is known), and the difference of sidereal time between the two transits noted at each. This difference, in consequence of the moon's motion in right ascension, is not the same at both stations; and its variation gives the difference of the longitude. By this means any error in the position of the transit instrument affects the star and the moon both alike; but it is erroneous to suppose that the method is independent of accuracy in the adjustment of the transit instrument; for if the instrument is out of the meridian, the resulting longitude will be in error by the amount of the moon's variation in right ascension during the corresponding interval.

6. *Lunar Distances.*—None of the methods which have yet been described (excepting that by chronometers) can be very conveniently applied to the important problem of determining the longitude of a ship at sea. In this case, no fixed or meridian instrument can be employed; and the observer can only measure the apparent distance of the moon's limb from a fixed star or planet with a sextant, or some reflecting instrument which can be held in the hand. For the purpose of rendering this method available to seamen, the distance of the moon from certain fixed stars is computed (several years previously) for every three hours of Greenwich time, and published in the *Nautical Almanac.* The moon's distance from one of these stars being observed on board a ship, and corrected for refraction and parallax, and the apparent time at the place and moment of observation being determined in the usual manner by the altitude of the sun or a known star, the difference between the apparent time of the observation and the apparent time at Greenwich *corresponding to the same distance*, interpolated from the *Nautical Almanac*, gives the longitude of the ship. The longitude may also be determined by azimuths of the moon or by its altitude, either absolute or relatively to a star observed with a zenith telescope. [LUNAR METHOD.]

In the projection of maps and charts it is necessary to assume a point of the equator as the origin of the longitudes. The meridian passing through this point is called the *first meridian*; and as its selection is perfectly arbitrary, it has been placed by different geographers at various parts of the earth—a circumstance which occasions some inconvenience in consulting works of geography. Modern geographers usually assume the meridian of the capital of their own country as the first meridian. English writers generally adopt the meridian of the Greenwich Observatory, for which the *Nautical Almanac* is computed; the French that of the Observatory of Paris.

[MERIDIAN.] Ptolemy, and the most celebrated of the ancient geographers, placed the first meridian at the Fortunate Islands (now the Canaries), which they conceived to be the utmost boundary of the habitable earth. The Arabian astronomers also counted the longitude from the Fortunate Islands; and many of the modern geographers have counted from the island of Ferro, one of the most westerly of the Canaries. The reason for fixing on this point was probably that as there was no land known to the west of the first meridian, the longitudes of all places would be reckoned in the same direction, or there would be no west longitude. The discovery of America destroyed the force of this reason. The inconvenience of counting in two directions is not very great; but it might be avoided by reckoning the longitude all round the circle to 360°, which would undoubtedly be an improvement on the present method.

Degrees of Longitude.—The figure of the earth being spheroidal, the degrees of longitude diminish as we proceed from the equator towards either pole. For the law of their variation, and their lengths on the different parallel circles, see DEGREE.

Geocentric Longitude is the longitude of a planet as seen from the earth; that is, the point of the ecliptic to which it perpendicularly corresponds as seen from the centre of the earth

Heliocentric Longitude is the longitude of a planet as seen from the sun. [GEOCENTRIC; HELIOCENTRIC.]

Longus Colli. The name of a pair of muscles of the neck: when one contracts, it moves the neck to one side; when they both act, the neck is bent forwards.

Lonicera (after Adam Lonicer, a German botanist). The botanical name of the Honeysuckle genus, of which many species occur in our gardens.

Loof. In a Ship, that part of the bow where the timbers begin to cant or curve in towards the stem.

Loom. [WEAVING.]

Looming. The indistinct and magnified appearance of objects seen in particular states of the atmosphere. [MIRAGE.]

Loopholes. In Fortification, apertures in the walls of fortified places, in stockades, &c., through which musketry fire may be directed upon the exterior ground. They correspond for musketry fire to *embrasures* for cannon. They were formerly made in the battlements of castles, to enable arrows and javelins to be shot from within.

Lopez. *Radix Lopeziana.* The name of the root of an unknown tree, supposed to grow at Goa: it is said to be remarkably effective in checking diarrhœa.

Lophine. A crystalline substance formed by the destructive distillation of AMARINE; it has also been called *pyrobenzolene.* The formula assigned to it is $C_{42}H_{17}N_2$.

Lophiodon (Gr. λόφος, *a crest*, and ὀδούς, *tooth*). A genus of fossil Perissodactyle Mammalia, remains of which have been found in the Eocene strata. The teeth present annectant affinities between *Tapirus* and *Rhinoceros.* The last two premolars are more simple in Lophiodon than in *Tapirus*; the inner side exhibiting one cone in the former, and two in the latter genus. It was, however, more nearly allied to *Tapirus* than to *Palæotherium* and *Rhinoceros.*

Lophiraceæ (Lophira, one of the genera). A natural order of hypogynous Exogens, belonging to the Guttiferal alliance. *Lophira* is the sole genus. They are tropical African trees, of no special interest.

Lophobranchiates (Gr. λόφος, and βράγχια, *gills*). An order of osseous fishes, comprehending those in which the gills are in the form of small tufts, and disposed in pairs along the branchial arches; as in the pipe-fish and hippocamp.

Lopholte. A variety of Ripidolite from Zillerthal in the Tyrol.

Lophotes (Gr. λόφος). A genus of Tænioid fishes, characterised by a short head, surmounted by a high osseous crest, to the summit of which a long and stout spine is attached, bordered behind with a membrane and a low fin, of which the rays are nearly all simple, and which extends from the occipital spine to the point of the tail; this is terminated by a distinct but very small caudal fin.

Lophyropods, Lophyropoda (Gr. λόφος, and πούς, *a foot*). The name of a section of Entomostracous Crustaceans, comprehending those species which have cylindrical or conical ciliated or tufted feet.

Lopping. In Arboriculture, the cutting off all the branches of a tree for the sake of the profit to be derived from them; as contrasted with pruning, by which some of the branches are cut off for the sake of the tree. The lopping of a tree, however, does not include the cutting off of the crop or leading shoot; and hence, when timber trees are sold, the purchaser bargains to take them either with or without the lop and crop, as the case may be.

Loranthaceæ (Loranthus, one the genera). A natural order of parasitical Exogens included by Lindley in his Asaral alliance. They principally inhabit the equinoctial regions of Asia and America, and are distinguished from *Caprifoliaceæ* and all other orders by their parasitical habit, and by the stamens being opposite to the petals. Brown suggests their relation to *Proteaceæ*; and, upon the whole, the structure of this order appears to be rather that of a polypetalous or apetalous than of a monopetalous order. Schleiden has made the startling assertion that they are gymnospermous. The bark is usually astringent. Their chief peculiarity is their power of rooting in the wood of other plants. They effect this when they first germinate by fixing their root upon the bark, and then by slow degrees introducing it into the tissue till they reach the wood, between the wedges of which they slightly insinuate themselves, thus placing their abortive

roots in the line of the current of ascending sap. They are generally beautiful plants, but are scarcely capable of cultivation. Mistletoe is the most northern species of the order.

Lorcha. The name of a coasting vessel used in the Chinese seas.

Lord (A.-Sax. hláf-ord, supposed by some to mean ord, the *origin* of hláf, *loaf*, but regarded by others as a corruption of hláf-weard, *the warder of bread*: Max Müller, *Lectures on Language*, 2d series, p. 255). A title of honour. It may be said to be either a title of hereditary dignity (as lord of parliament); or a title expressing certain powers, as lord of a manor, lord chancellor, lord of the treasury, &c. The eldest sons of earls, and all the sons of dukes and marquises, are styled lords by courtesy.

Lord Advocate of Scotland. [ADVOCATE.]

Lord Keeper. [CHANCELLOR; KEEPER.]

Lord Privy Seal. [SEAL.]

Lord's Supper, The. [EUCHARIST.]

Lord-Lieutenant of Ireland. The chief executive officer of the Irish government, representing in some respects the person of the king. The first viceroy or lieutenant of Ireland appears to have been appointed in the reign of Henry II.; and by Acts of Parliament passed in the reigns of Richard III. and Henry VIII. provision was made for the election of a governor by the chancellor, treasurer, or other high officers of the government, on the death or resignation of a lieutenant, until the king's pleasure were known. The chief officer in Ireland has been variously styled at different times; as custos or keeper, justiciary, warden, procurator, seneschal, constable, deputy, and lieutenant. He is appointed by letters patent durante bene placito. He has a council, composed of the great officers of the crown in Ireland and others appointed by the crown. He corresponds with the secretary for the home department; but the management of the affairs of the Irish government in London is chiefly intrusted to the secretary for Ireland, who is also chief secretary of the lord-lieutenant. He has also a household, consisting of a private secretary, steward, comptroller, chamberlain, gentleman usher, master of the horse, and subordinate officers. His salary has been usually 20,000*l.* per annum.

Lords-Lieutenant of Counties. In England and Wales, officers appointed by the king, and intrusted by parliament with full power and authority to call together, arm, and array the militia, and cause them to be trained and exercised once every year. Each may appoint twenty or more deputy-lieutenants, who must have 200*l.* a year freehold estate; except in the Welsh and some small English counties, where the qualification is only 150*l.* The lord-lieutenant also nominates officers in the militia and yeomanry: but the names both of deputy-lieutenants and officers must be laid before the king; and if he, within fourteen days, expresses disapprobation, the commissions do not issue.

Lordship. [LEET.]

Lore (Lat. lorum, *a thong*). In Ornithology, signifies the space between the bill and the eye, which is bare in some birds, as in the great crested grebe; but is generally covered with feathers. In Entomology, the term is applied to a corneous angular machine observable in the mouth of some insects, upon the intermediate angle of which the mentum sits, and on the lateral ones the cardines of the maxillare, and by means of which the trophi are pushed forth or retracted, as in the Hymenopterous insects.

Lorica (Lat.; Gr. θώραξ). A cuirass or crest of mail, made of leather and set with plates of metal in various forms, chiefly in rings like a chain, used by the Roman soldiers.

Loricates, Loricata (Lat. lorica). The name given by Merrem to an order of reptiles dismembered from the Sauria of Cuvier, and including those species, as the Crocodile, which are protected by an armour of bony plates.

Lorication (Lat. loricare, *to crust over*). A term of old Chemistry, signifying the application of a lute or coating to glass and other vessels.

Lorimer (from Lat. lorum). A name formerly given to the makers of bits, spurs, and other articles of iron used for horses.

Loris. [STENOPS.]

Lory. A tribe of birds composed of several genera, closely allied to the Parrots: remarkable for their very soft beaks. They are to be found in most of the islands of the Indian Archipelago, and in Australia.

Lotalite. A greenish-grey mineral found at Peterlow in Finland.

Lote-tree (Gr. λωτός). Of this there were two kinds: the one a small plant, from which the *Lotophagi* derived their name; the other a tree with cut leaves and very hard wood. The former is reputed to be the *Zizyphus Lotus*, the latter the *Celtis australis*. The true Lotus of the ancients has been, however, with more probability referred to *Nitraria tridentata*. In the Hindu Mythology, the Lote-tree is regarded as the symbol of creation. [LOTOPHAGI.]

Lothian. A name common to that part of Scotland which stretches along a considerable part of the southern shores of the Frith of Forth, and comprehends three counties, Haddingtonshire, Edinburghshire, and Linlithgowshire; otherwise called East, Mid, and West Lothian. The etymology of the name is doubtful. Lothian was taken possession of by the Saxon invaders A. D. 450, and became the scene of contest between the Saxon-Gaels and Scoto-Irish, and was at length ceded to Malcolm II. in 1020. Lothian was considered as a country wholly distinct from Scotland in the reign of David I., and the period of its incorporation with the rest of the country is assigned to the eleventh or twelfth century.

Lotion (Lat. lotio). A mixture of different ingredients, or a solution of various medicinal substances, in water or other menstrua, designed for external application. Indolent ulc and tumours require stimulating lotions; whereas

sedative and narcotic mixtures are used to alleviate pain.

Lotophagi (Gr. λωτοφάγος, *a lotus-eater*) In Homeric Mythology, the name of the people inhabiting a country to which Ulysses was carried (*Odyss.* ix. 82) while trying to double Cape Malea in the Peloponnesus. (Gladstone's *Homer and the Homeric Age*, vol. iii. p. 320.) According to the legend, those who ate the fruit forgot their friends and country, and wished only to remain idle in the land of the Lotus.

Lottery (Ger. loos, *lot*). A lottery may be defined as a game of hazard, in which small sums are ventured for the chance of obtaining a larger value, either in money or other articles. Lotteries are formed on various plans; but in general they consist of a certain number of tickets drawn at the same time, with a corresponding number of blanks and prizes, by which the fate of the tickets is determined. In modern times this species of gaming has been sanctioned at different periods by most of the European governments, as a means of raising money for public purposes. The earliest English lottery of which there is an authentic record was drawn in 1569, when 400,000 tickets were sold at ten shillings each. The prizes consisted chiefly of plate, and the net profits were intended to be appropriated to repairing the harbours of the kingdom and other public works. In 1612 a lottery was drawn for the benefit of the English colonies; and, in the course of the same century, the desire for embarking in speculations of this kind gave rise to so many private undertakings, many of which were formed on the most fraudulent principles, that, in the beginning of Queen Anne's reign, parliament found it necessary to suppress *private* lotteries 'as public nuisances.' The year 1709 saw the birth of the first state or parliamentary lottery; and from that time down to 1823 they were annually licensed by Act of Parliament, under a variety of regulations. In the very early part of last century the prizes were paid in the form of terminable annuities. Thus in 1746 a loan of 3,000,000*l.* was raised on 4 per cent. annuities, and a lottery of 50,000 tickets, at 10*l.* each; and in the following year 1,000,000*l.* was raised by the sale of 100,000 tickets, the prizes in which were funded in perpetual annuities, at the rate of 4 per cent. per annum. During the same century government constantly availed itself of this means to raise money for various public works, of which the British Museum and Westminster Bridge are well-known examples. But at the commencement of the present century a great repugnance began to be manifested in parliament to this method of raising any part of the public revenue, in consequence of the spirit of gambling which it tended to foster in the great body of the people; and the evil at last became so palpable, that, in the year 1823, the legislature consented to the entire abolition both of state and private lotteries. It would be superfluous to enter into any argument to point out how prejudicial all such establishments must be to public morals, by giving the countenance of government to a system of gambling, by which the mind is misled from habits of continued industry to dreams of sudden wealth, which, in the great majority of instances, must end in ruin. Those who wish to see the results of this system of finance exhibited in its true colours, will find ample information in the two parliamentary reports presented to the House of Commons on the subject of lotteries in 1808; but the following passage from the *Wealth of Nations* illustrates clearly and forcibly their principle and operation:—

'The world neither ever saw, nor ever will see, a perfectly fair lottery, or one in which the whole gain compensated the whole loss: because the undertaker could make nothing by it. In the state lotteries, the tickets are really not worth the price which is paid by the original subscribers, and yet commonly sell in the market for twenty, thirty, and sometimes forty per cent. advance. The vain hope of gaining some of the great prizes is the sole cause of this demand. The soberest people scarce look upon it as a folly to pay a small sum for the chance of gaining 10,000 or 20,000 pounds; though they know that even that small sum is perhaps 20 or 30 per-cent. more than the chance is worth. In a lottery in which no prize exceeded 20*l.*, though in other respects it approached much nearer to a perfectly fair one than the common state lotteries, there would not be the same demand for tickets. In order to have a better chance for some of the great prizes, some people purchase several tickets, and others small shares in a still greater number. There is not, however, a more certain proposition in mathematics, than that the more tickets you adventure upon, the more likely you are to be a loser. Adventure upon all the tickets in the lottery, and you lose for certain; and the greater the number of your tickets, the nearer you approach to this certainty.' (Degerando's *Bienfaisance Publique* l. ii. ch. vi.)

State lotteries were abolished in France in 1836, along with the gambling houses, from which a great revenue had been derived. They still exist in several of the German states. That of Hamburg is established on a comparatively fairer principle than was adopted either in France or England; the *whole* money for which the tickets are sold being distributed among the buyers, except a deduction of 10 per cent. made from the amount of the prizes at the time of their payment.

Lough. An Irish term, synonymous with the Scotch *loch*, but not with the English *lake*; for loch and lough are applied to designate arms of the sea, as well as collections of fresh water, which *lake* is not.

Louis, St., of France. A royal military order, founded by Louis XIV. in 1693. The badge is a cross of eight points, with fleur-de-lis, and bearing a circular shield containing the effigy of St. Louis.

Louis d'Or. A gold coin under the old system of France, first struck under Louis XIII.

in 1641, from whom they derived their name. The louis d'ors, says Kelly, coined before 1726, which passed then for 20 livres, were coined at the rate of $36\frac{1}{4}$ per French mark of gold 22 carats fine. From the year 1726 to 1785 louis d'ors were coined at the rate of 30 to the mark of gold; and about this period all the gold coins in France were ordered to be brought to the mint to be melted down; and a new coinage then took place, at the rate of 32 louis d'ors to the mark of the same degree of fineness, with a remedy of 15 grains in the weight, and $\frac{12}{32}$ of a carat in the alloy. The intrinsic value of this new coin was 18*s.* $9\frac{1}{4}$*d.* sterling. Louis d'ors were formerly regarded as a current coin in all parts of the Continent; but in England they are sold merely as merchandise, and their value has fluctuated from 18*s.* 6*d.* to 21*s.* sterling.

Louping-ill. The name applied, in the case of sheep and cattle, to the disease known as the Mad Staggers, when it attacks the horse.

Louse. The *Pediculus Hominis* of Linnæus, a small parasitic apterous insect; well known, and usually found on those individuals who neglect personal cleanliness. It proceeds from a small egg, or *nit*, and is distributed amongst nearly all known domesticated animals; the species, however, differing usually from those found in man.

Louvre. One of the most ancient palaces of France. It existed in the time of Dagobert, as a hunting seat; the woods then extending all over the actual site of the northern portion of Paris, down to the Seine. The origin of its name has not been satisfactorily ascertained. It was formed into a stronghold by Philip Augustus, who surrounded it with towers and fosses, and converted it into a state prison, for confining the refractory vassals of the crown. It was then without the walls of Paris; but on their extension in the latter part of the fourteenth century, it was included in their circuit. Charles V. made additions to it. That part of the palace now called the Vieux Louvre was commenced under the reign of Francis I., after the designs of Pierre l'Escot, abbot of Clugny. When Charles IX. resided in the Louvre, he began the long gallery which connects it with the Tuileries, built for his mother by Philibert de l'Orme: this gallery now holds the celebrated collection of paintings; it was finished by Henry IV. Louis XIV. erected the peristyle that formed the entrance to the Vieux Louvre (since materially altered) from the side of the Tuileries, after the designs of Lemercier. That monarch also gave a beginning to the modern portion of the Louvre, by erecting, after Perault's design, the great eastern front: and subsequent monarchs have slowly advanced it towards completion, especially Napoleon I. The eastern front exhibits a façade of great beauty, though it is sadly out of harmony with the architecture of the interior and of the inner quadrangle. (See the criticism of Mr. Fergusson in his *History of the Modern Styles of Architecture.*) Of late years, the Louvre has been connected with the Tuileries, at an immense expense, but with supreme talent, by the late M. Visconti, assisted by M. Lefeuille; and the united palaces form a mass imposing and magnificent in the extrême. Besides the gallery of paintings above mentioned, which contains some of the finest works of art in the world, the Louvre contains a matchless collection of antiquities, and other specimens of art; the collection of Roman and Græco-Roman sculpture, and of Etruscan ornaments, is unrivalled.

Love Apple. The Tomato, *Lycopersicum esculentum*, whose fruit forms an excellent ingredient in soups, sauces, and gravies, and is also extensively used in various other ways.

Love, Family of. A sect of fanatics in the sixteenth century, holding tenets resembling those of the early Anabaptists. There is a proclamation against them by Queen Elizabeth, dated from her manor of Richmond, 1580.

Love Feasts. Religious meetings held quarterly by the Methodists, to which members of their church alone are admitted, and that only on presenting a ticket or a note from the superintendent. They are retained in imitation of the AGAPÆ [which see] held by the early Christians.

Low Sunday. In Ecclesiastical Antiquities, the Sunday next after Easter has been popularly so called in England; perhaps by corruption for *close* (Pascha clausum, *close of Easter*, one of the many names by which it was known in the Christian church).

Löweite. A yellowish or reddish mineral product, found at Ischl in Austria. It is a sulphate of magnesia and soda.

Lower Empire. A name sometimes applied to the Roman empire, from the removal of the imperial seat to Constantinople down to its extinction on the capture of Constantinople by the Turks in 1453.

Lower Eocene. The Lower Eocene deposits are best developed in the London and Hampshire basins. and can be studied there in great detail. They are very rich in fossils, including a great variety of plants, of which the fruits alone remain, and many quadrupeds of extreme interest. On the whole, they may be said to underlie the great Paris series, with which they were long compared.

The following is the division of these beds suggested by Mr. Prestwich as best showing the position of the deposits in England:—

UPPER SERIES	London clay	
	Basement bed of the London clay	
LOWER SERIES	Woolwich and Reading series	Upper
		Middle
		Lower
	Thanet sands	

Lower Eocene formations under various names are known in many parts of Europe, Asia, and both North and South America, and range into North Africa. The NUMMULITIC FORMATION is

one of the most important representatives. The Monte Bolca and Mount Lebanon beds, celebrated for their fossil fish remains, are at the bottom of these Tertiaries. So also are the *Santee limestone* of North America and some of the green earths of New Jersey U.S. The older tertiaries as a group are very rich in organic remains. [EOCENE; LONDON CLAY.]

Lower Greensand. The name given by English geologists to the lower division of the Cretaceous series of rocks as developed in the south-eastern part of the British Islands. The name *greensand* was originally given to the sands beneath the chalk, because in many places, though red in colour, they are found to be full of green particles, owing to the presence of scales of silicate of iron. Beds of this kind are developed very largely in our own islands. Deposits of the same age are found also on the Continent, especially in the north of Switzerland at Neufchâtel. These beds are typical; and under the name *Neocomian*, which probably includes some part of our Wealden period, important deposits occur in Switzerland.

The lower greensand is rich in fossils, many of them very characteristic. The *Perna mulleti*, a large bivalve shell, is common in the typical beds Shells of cephalopodous molluscs, varying greatly in form, abound in the rocks of this period.

The Isle of Wight presents admirable sections of the lower greensand, and serves to connect the beds known under this name with the typical Neocomian deposits. [NEOCOMIAN]

Löwigite. A variety of Alum-stone found at Tolfa in Italy and Tabrze in Siberia, and differing from ordinary Alum-stone only in containing a less amount of water. Named after Löwig, by whom it was analysed.

Loxia (Gr. λοξός, *crooked*). A genus of Conirostral Passerine birds, characterised by having a compressed beak, and the two mandibles so strongly curved that their points cross each other, sometimes on one side, sometimes on the other. The crossbill (*Loxia curvirostra*) is the type of this genus.

Loxoclase (Gr. λοξός, and κλάω, *I break*). The name given by Breithaupt to the Felspar which occurs with Pyroxene in the Laurentian rocks of Hammond, St. Lawrence county, New York. It has the cleavage, density, and composition of Orthoclase, and is remarkable for the large amount of soda which it contains.

Loxodromic Curve (Gr. λοξός, and δρόμος, *a course*). A curve which cuts at a constant angle all the lines of curvature of a surface which belong to one and the same system. In the case of a surface of revolution, the trajectories of the meridian lines are loxodromic curves. A ship sailing always towards the same point of the compass, or on the same rhumb, describes a loxodromic curve; it is manifestly a kind of spiral which approaches the pole asymptotically. The differential equation of a loxodromic curve on the sphere is easily found. In fact, if ϕ be the arc of the meridian intercepted between any point of the curve and the pole, and λ the longitude of that point, then the infinitely small arc of the parallel of latitude corresponding to an increment of the curve is $d\lambda \sin\phi$, and the differential of the co-latitude is $d\phi$; but, because the curve cuts all the meridians under the same angles, the variation of the parallel of latitude corresponding to an increment of the curve is proportional to the variation of the co-latitude; consequently $a\ d\lambda \sin\phi = d\phi$, or $a\ d\lambda = \dfrac{d\phi}{\sin\phi}$, which is the differential equation required. By integration, the equation of the loxodromic curve is at once found to be $\tan\dfrac{\phi}{2} = c\,e^{a\lambda}$, where c is a new constant. From this it is at once manifest that the stereographic projection of a loxodromic curve on the sphere is a logarithmic spiral, the centre of projection being at the pole opposite to the one from which the angles ϕ are measured.

Lozenge (Fr. losange). In Heraldry, a bearing in the shape of a parallelogram, with two obtuse and two acute angles. The arms of maidens and widows are borne on shields of this shape.

LOZENGE. In Mathematics, a synonym for *rhombus*, being an oblique-angled equilateral parallelogram.

LOZENGE. In Pharmacy, a medicinal substance made up into a small cake, to be gradually dissolved in the mouth. Sugar, gum, and starch are the usual inert parts of lozenges; and minute quantities of active substances are added, according to the purposes for which they are intended: such as ipecacuanha or squills, for pectoral lozenges; extract of poppies or opium, for sedative lozenges; cayenne pepper as a stimulant; oil of peppermint as an anti-spasmodic, &c.

Lubber's Hole. On Shipboard, an entrance to the top, by which it is reached without passing over the futtock shrouds. It is the easier though slower way, and is regarded by sailors as only worthy of a lubber.

Lubricator (Lat. lubricus, *slippery*) An arrangement for lubricating the bores of rifled guns, and thus removing the solid residue from the powder which would otherwise be left in the bore, and clog the grooves. It consists, in our service, of a copper wad, containing equal parts of tallow and oil, next the projectile, then a felt wad, and then a millboard disc, all joined together. The explosion of the charge drives the copper wad against the projectile, and releases the lubricant; which the felt wad, acting as a mop, wipes up and carries forward.

In Machinery, the term *lubricator* is applied to the arrangement by which the bearings of the engine are preserved from the effects of friction by means of oil or grease.

Lucanidæ (Gr. λύκος, *a wolf*; also the name of an insect). A family dismembered from the Linnæan genus *Lucanus*, and including tl insects which, in addition to the comprehensive characters of the original genus, present antennæ strongly geniculate, glabrous, or but slightly

pilose; the labrum very small, or confounded with the epistome; maxillæ terminated by a membranous or coriaceous, silky, pencilliform lobe; edentate, or with one tooth; and a ligula either entirely concealed or incorporated with the mentum, or divided into two narrow, elongated, silky lobes, extending more or less beyond the mentum. The scutellum is situated between the elytra. The stag-beetle, *Lucanus cervus*, &c., is the type of this family. The subgenera are *Œsalus*, *Lamprina*, *Sinodendrum*, &c.

Lucanus. A Linnæan genus of Coleoptera, forming the type of a tribe of Lamellicorn beetles (*Lucanina*) in the system of Latreille, by whom it is thus characterised: Antennæ composed of ten joints, the first of which is usually much the longest; the antennal club has its leaflets or teeth arranged perpendicularly to its axis, in the manner of a comb. The mandibles are always corneous, and most commonly exhibit a sexual superiority of developement and peculiarity of form in the males. The maxillæ are generally terminated by a narrow, elongated, and silky lobe; but sometimes are entirely corneous and dentated. The ligula in most of the *Lucanines* is formed of two small silky pencils, projecting more or less beyond an almost semicircular or square mentum. The anterior legs in the greater number are elongated, and their tibiæ dentated along the whole of their outer side. The tarsi terminate in two equal and simple hooks, with a little appendage with two setæ between them. The elytra cover the whole of the upper part of the abdomen. The insects thus characterised were first divided by the immediate successors of Linnæus into two genera, *Lucanus* proper and *Passalus*, both of which are now elevated to the rank of families, and subdivided into numerous subgenera. [LUCANIDÆ; PASSALIDÆ.]

Luceres (Lat.). In Roman History, the name given to a division of the Roman populus or patricians. Livy (i. 13) speaks of the origin of this name as unknown, but describes the Luceres with the Ramnenses and Titienses as centuries of knights. [EQUITES.] Elsewhere (x. 6) he speaks of them as being the three ancient tribes. (Sir G. C. Lewis *On the Credibility of Early Roman History*, ch. xi. sec. i.)

Lucern. The *Medicago sativa*, a well-known plant of the natural family *Leguminosæ*. There are many species of *Medicago*, but of these the artificial grass, called Lucern, is most deserving of notice. This plant was in high estimation among the ancients; and its nutritious qualities, easy cultivation, rapid growth, and luxuriant properties, have placed it in the first rank of vegetable food for cattle, even in the present times. 'Lucern,' says an old writer, 'is commended for an excellent fodder. . . . There is not any pulse or other feeding which is more agreeable or more precious for feeding beasts than lucerne: so that it may seem to spring out of the earth. . . as a more especial favour from God, not only for nourishing and fattening herds of cattle, but also to serve as a physic for beasts that are sick.' (*Country Farm.* 3rd edit. fol. 1616, p. 364.) Those who wish to see the properties of this plant fully developed, and its history traced from its discovery during the Persian expedition under Darius to its subsequent introduction successively into Greece, Italy, Spain, France, and Germany, down to its arrival in England, will find ample details in the learned *Essays on Husbandry* by the Rev. Walter Harte (London 1770). The origin of the term *lucern* is involved in obscurity. Some authors have derived it, naturally enough, from the canton in Switzerland of that name; but from the account given by Mr. Harte of the history of this plant, it does not appear either that Switzerland was particularly famous for producing it, or that the northern or western nations of Europe received it thence. It is cultivated successfully in the lowland part of Essex, where a deep calcareous loam and a favourable climate combine to make it a most productive forage crop.

Lucernaria (Lat. lucerna, *a lamp*). A genus of fleshy polypi (*Polypi carnosi*) in the system of Cuvier, characterised by a long and slender pedicle supporting a radiated disc, which sends off numerous tentacula united in bundles. Cuvier regarded the *Lucernariæ* as being nearly allied to the *Actiniæ* or *sea-anemones*; but their substance is softer. They emit phosphorescent light.

Lucifer (Lat. *light-bearing*). The morning star. A name given to the planet Venus, when she appears in the morning before sunrise. When Venus follows the sun, or appears in the evening, she was called *Hesperus*, the evening star. These names no longer occur except in the old poets.

Lucifers. This term was originally applied to matches tipped with a mixture of chlorate of potash and sulphuret of antimony which were inflamed by friction upon a piece of emery paper. These have been superseded by a variety of mixtures containing phosphorus. The manufacture of lucifers now forms a vast trade, which in this country alone consumes upwards of eight tons of phosphorus and twenty-six tons of chlorate of potash in tipping them. The process of making them is almost wholly performed by machinery. It has been found that the ill effects caused by the employment of common phosphorus on the health of the workmen may be prevented by using in its stead the *red* or *amorphous* phosphorus, which with manganese and glue is made into a friction-paste for covering the side of the boxes. Such matches, as not being affected by accidental friction, and as being free from poison, are called safety matches.

Luciferians. The name of a sect of schismatics, so called from Lucifer, bishop of Cagliari, in the fourth century, who refused to hold any communion with the clergy who had conformed to the Arian doctrines, and whom a synod at Alexandria, A.D. 352, had determined to readmit into the church on condition of an open acknowledgement of their

errors. His followers are little heard of after the time of Theodosius the Great. [SCHISM.]

Lucina. [LUNA.]

Lucullite. A black limestone often polished for ornamental purposes, to which it is said first to have been applied by Lucullus the Roman consul, who originally carried it to Rome from an island in the Nile.

Lucuma (its Peruvian name). A genus of *Sapotaceæ* found in the West Indies and South America, and comprising numerous shrubs or tall trees, one of which, *L. mammosum*, called the Marmalade-tree, is cultivated for the sake of its fruit, which contains a thick agreeably flavoured pulp bearing some resemblance in appearance and taste to quince marmalade.

Ludlow Formation. The upper member of the typical Silurian series in England. It is well developed near the town of Ludlow, and is there recognised by distinct groups of organic remains.

It is subdivided into three principal members, (1) Upper Ludlow sands and shales, (2) Aymestry limestone, and (3) lower Ludlow shales, with concretions of limestone. The whole series is rich in organic remains, many of them characteristic and easily recognised. Certain groups of *trilobites* are especially developed in these uppermost Silurian rocks, but they are all wonderfully rich in fossils. The total thickness of the Ludlow formation in England and Wales is estimated at not less than 2,000 feet.

The Ludlow formations are well represented in Bohemia, together with the other principal divisions of the Silurian series. They extend also to Scandinavia and Russia, but generally under a very different appearance, being identified only by the groups of fossils.

Lues (Lat.). As a Medical term, poison or pestilence; a plague.

Luff. The foremost or weather edge, or leech of a fore-and-aft sail. *To luff*, to bring the ship's head nearer the wind.

Luffer Boarding or **Louvre Boarding.** In Architecture, boards placed in an aperture above each other at regular intervals, and inclined to the horizon at an angle of 45°, so as to admit air to the interior without allowing the rain to penetrate.

Lug-sail. A four-sided sail bent to a yard, which is slung nearly horizontally, about one-third of its length from the windward end.

Lugger. A small vessel carrying two or three masts, with a lug-sail on each; it is capable of beating very closely up to the wind.

Lumachella. Shell marble; the fragments having a pearly lustre, it is sometimes termed *fire marble*. The finest specimens are from the lead mines of Bleiberg, in Carinthia.

Lumbago. Rheumatism.

Lumbar Abscess (Lat. lumbus, *the flank*). An abscess of the loins formed upon the psoas muscle; it is frequently mistaken for nephritic or rheumatic disease, and, when it forms a swelling in the groin, for hernia.

Lumber. In a trading vessel, the name applied to small spars, &c., as handspikes, anchor stocks, gaffs, &c.

Lumbrical Muscles (Lat. lumbricus, *an earthworm*). Small muscles of the hand which assist in bending the fingers.

Lumbricus (Lat.). A Linnæan genus of Vermes, now the type of a family (*Lumbricinæ*), which ranks as the first of the Setigerous Abranchian Anellidans in the system of Cuvier. All the species of this family—the *earthworms*, as they are commonly called—are characterised by a long cylindrical body, divided by rugæ into a great number of rings, and by an edentate mouth. The common earthworm (*Lumbricus terrestris*, Linn.) attains nearly a foot in length, and is composed of upwards of one hundred and twenty rings. This species is extremely abundant: they traverse the soil in every direction, swallowing quantities of earth, together with portions of roots and ligneous fibres, and other organised substances, which they assimilate for their own nutriment. Their castings constitute a rich soil.

In gardens and cultivated ground earthworms are rather beneficial than otherwise, by rendering the soil permeable to water, and mixing its constituents. It is only when they occur in lawns and gravel-walks that they become troublesome, and then only because their *casts* disfigure the surface. In such situations they may be removed or destroyed by the use of clear lime-water, made with quick-lime.

Luna. In Latin Mythology, the moon, worshipped along with Sol, the sun. She had a temple at Rome on the Aventine. The name is a later form of Luc-na, and recurs in that of Lucina, the goddess who presided over childbirth, from the same root with lux, luceo, and Greek λευκός, *white*.

Luna Cornea. Fused chloride of silver; so called from its horn-like appearance, luna being the term by which the old chemists designated silver.

Lunacy. In Law, strictly, the condition of an insane person who has lucid intervals, which in former times were supposed to depend on the phases of the moon; whence such persons were styled *lunatici*. But, for convenience, the term is commonly used as embracing the condition of all those who are under certain legal disabilities on account of mental deficiency, such as idiots, fatuous persons, &c.; all, in short, who are of unsound mind. The chief of these disabilities are: incapacity to make contracts, either personal or affecting the estate; to sue or defend in courts of justice; to perform offices and duties; to make devises or bequests. By an ancient legal maxim, the sovereign has the custody of lunatics. This is in practice delegated to the keeper of the great seal, by virtue of the sign manual. His powers are now regulated by the Lunacy Act, 16 & 17 Vict. c. 70, and several amending statutes. Applications for a commission of lunacy are consequently directed to him. When he determines that such a commission is proper, it issues to certain commissioners, now styled masters, appointed by the same authority. But the Lord Chancellor has of late delegated this function

to the Lords Justices. [CHANCELLOR.] By a recent enactment (25 & 26 Vict. c. 86), the enquiry by a jury into the state of mind of the party, formerly tried before one of the masters in lunacy, is now tried in one of the superior courts of law at Westminster. If the lunatic recover, the inquisition may be superseded. On the return of the inquisition, the custody of the lunatic's person and estate devolves on the crown; and the chancellor, on petition, appoints *committees* to have the custody of either or both. These may be any whom the chancellor thinks fit, although next of kin are ordinarily preferred. Lunatics are maintained by an allowance out of their own estate; when they have none, by statute, in public asylums. The custody of lunatics by private individuals is under the control of stat. 8 & 9 Vict. c. 100 and subsequent amending Acts, by which the powers vested in the Commissioners in Lunacy are placed on an entirely new footing, and efforts have been made to improve the management and condition of lunatics, which promise to be followed by the best results. Persons of unsound mind who are paupers, and those who have been tried for offences and found insane, and also lunatic convicts, are usually confined in county lunatic asylums, wherever these are established. As to the statistics of lunatic hospitals or asylums, see Degerando, *De la Bienfaisance Publique*, vol. iv. part iii. book iii.

The incapacity of a person of unsound mind to commit a crime depends, it is said, upon his irresponsibility, moral and legal. The general mode of directing a jury has been that they should acquit the prisoner, if satisfied that he had not a sufficient degree of reason to know that he was doing an act that was wrong, a test definitely laid down by the judges in Macnaughten's cause in the year 1843, and always since adopted. On acquittal taking place on evidence of lunacy, the jury are now required, by 39 & 40 Geo. III. c. 94, to find specially whether the person was insane at the time of committing the offence; and on that finding he is taken into public custody. The law of lunacy in Scotland is regulated by the recent Act, 20 & 21 Vict. c. 71.

Lunar Bone. One of the bones of the wrist.

Lunar Caustic. Fused nitrate of silver.

Lunar Cycle. The period of time after which the new moons return on the same days of the year. [CYCLE.]

Lunar Distance. In Navigation, the distance of the moon from the sun, or from a fixed star or planet; by means of which the longitude of a ship is found.

Lunar Method. In Astronomy and Navigation, the method of determining the longitude of a place or ship from the observation of *lunar distances*. This problem, which is of the highest importance, on account of its being the handiest astronomical method of finding the longitude at sea, resolves itself into two parts. The first is to ascertain the distance of the moon's centre from one of the principal planets or fixed stars, or the sun, at a given moment; and the second, to find the Greenwich time to which, according to the tables, that distance corresponds. The general method of procedure may be explained as follows: Six or eight observations of the star's distance from the nearest point of the moon's limb are taken with a sextant as quickly in succession as possible, and the corresponding time at each observation noted: the mean of the observed distances, at the mean time, gives a single distance corresponding to a known instant of time. The true mean time is here supposed to be given by the chronometer, the rate and error of which are determined by observations of altitude. Contemporaneously with the observations of distance, two assistants are sometimes employed in taking the altitudes both of the moon and star, for the purpose of applying the proper corrections for refraction, &c. The remainder of the operation consists in making the requisite calculations. In the first place, the moon's semidiameter is added to the observed distance, whereby the true apparent distance is found. In the next place, the corrections are applied for refraction and parallax, and the apparent distance reduced to the centre of the earth. This part of the operation is technically called *clearing the distance*. The computer then turns to the *Nautical Almanac*, in which the distances of the moon from the sun and some of the principal stars and planets are given for every three hours. Having found in the almanac the distances next less and greater than the true distance deduced from the observations, their difference gives the change of distance in three hours; whence, by interpolation, the Greenwich time is obtained at which the distance was exactly the same, and consequently the Greenwich time corresponding to the apparent time at the instant of the observation.

This method of finding the longitude at sea was first proposed by John Werner of Nuremberg so early as 1514, and recommended by several other astronomers who lived during the same century; but the theory of the lunar motions was then, and for a long time after, too imperfect to allow of its practical application; and before the invention of Hadley's quadrant, there was no instrument by which the distances could be measured with the requisite precision. The advancement of astronomy, and the perfection of instruments of observation, have obviated all difficulties; and the method of lunar distances is now mainly relied on by the mariners of all countries.

Lunar Month. The time in which the moon completes a revolution about the earth, and returns to the same position relatively to some celestial body, or point in space, with which her motion is compared. But the moon's period may be determined in relation to several objects—as the sun, the equinoctial points, a fixed star, the perigee or nodes of her orbit; and accordingly there are as many different lunar

months as there are assumed points of comparison, provided these points have different motions in the heavens.

1. The proper *lunar month* is the same as the *lunation* or *synodic month*, and is the time which elapses between two consecutive new or full moons, or in which the moon returns to the same position relatively to the earth and sun.

2. The *periodic month* or *synodic month* is the revolution with respect to the movable equinox.

3. The *sidereal month* is the interval between two successive conjunctions with the same fixed star.

4. The *anomalistic month* is the time in which the moon returns to the same point (for example, the perigee or apogee) of her movable elliptic orbit.

5. The *nodical month* is the time in which the moon accomplishes a revolution with respect to her nodes, the line of which is also movable.

The exact *mean* lengths of these different lunar months are as follow:

	d.	h.	m.	s.
Synodic month . .	29	12	44	2·84
Tropical month . .	27	7	43	4·71
Sidereal month . .	27	7	43	11·54
Anomalistic month .	27	13	18	37·40
Nodical month . .	27	5	5	35·60

These *mean* motions are not uniform, but are subject to periodic and secular variations. [MOON.]

Lunar Year. The period of twelve synodic lunar months, containing consequently 354 days; the lunar months in the calendar being alternately 29 and 30 days. The exact period of 12 lunar months is 354 days 8 hours 48 min. 34 sec.; so that the lunar year of the calendar requires to be adjusted by intercalation every third year. [CALENDAR.]

Lunatic (Lat. lunaticus, from luna; Gr. σεληνιακός, from σελήνη, *the moon*, which was supposed to regulate their periods of insanity). [LUNACY.]

Lunation. The period of a synodic revolution of the moon, or the time from one new moon to the next one, in which time the moon passes through all her phases.

Lune (Lat. luna, *the moon*). This word formerly indicated the crescent-shaped plane figure, bounded by two circular arcs. Hippocrates of Chios accomplished the quadrature of such a figure. The term *lune*, however, is now used to denote that portion of the surface of a sphere which is enclosed between two great circles.

Lunette (Fr.). In Architecture, an aperture for the admission of light in a concave ceiling.

LUNETTE. In Fortification, a detached work consisting of two faces and two flanks. It is especially applicable to the defence of a fortress when its faces can be directed so that its glacis can receive flank defence from the fortress, or other detached works within moderate range. It is in general the best form of detached work. [FORTIFICATION.]

Lungs (Ger. lungen). The viscera by which respiration is carried on. In the human subject the right lung is divided into three lobes, the left into two. They are, as it were, suspended in the chest by the *trachea*, and separated by the *mediastinum*; they are also attached to the heart by the pulmonary vessels. They are nourished by the bronchial artery, which is a branch of the aorta; and the pulmonary artery carries the venous blood through them from the heart, to subject it to the action of the air in their cellular structure: the blood when arterialised returns to the heart by the pulmonary veins, the four trunks of which enter the left auricle. The bronchial veins terminate in the vena azygos. The nerves of the lungs are from the eighth pair and great intercostal.

Lungwort. In Botany, the common name for *Sticta pulmonacea*, a lichen which grows extensively on the trunks of trees, and is occasionally used in medicine. In Siberia it is said to be employed as a substitute for hops. The same name is also applied to the genus *Pulmonaria*.

Lunisolar (Lat. luna, *the moon*, and sol, *the sun*). Combining the motions of the sun and moon. A lunisolar period is that after which the eclipses again return in the same order. [CYCLE.] The Dionysian period of 532 years, formed by multiplying together the solar and lunar cycles of 28 and 19 years, has sometimes been called the lunisolar year.

Lunnite. A variety of Phosphocalcite or hydrated phosphate of copper, occurring in radiating fibrous masses of a beautiful emerald-green colour.

Lupercalia. A Roman festival in honour of Lupercus, an agricultural god, who was invoked for the fertility of the land and as a protector against wolves. Livy held it to be the same with an Arcadian festival of the god Pan, and to have been introduced at Rome by Romulus. (Lewis's *Credibility of Early Roman History* ch. viii. sect. iv.) The festival recurred yearly in February, and was of a peculiarly rude character. The priests ran naked, and with thongs of goat-skin touched the crowd, and especially women, a practice arising originally from the habit of touching the flocks to insure their increase.

Luperci. The Roman priests of Lupercus. There were three companies of them; viz. the Fabiani, Quintiliani, and Julii—the last of whom were founded in honour of Julius Cæsar. [LUPERCALIA.]

Lupia (Gr. λυπέω, *I molest*). An encysted tumour.

Lupinite. A bitter substance, extracted from the leaves of the white lupin.

Lupinus (Lat.). A very ornamental genus of papilionaceous *Leguminosæ*, of which many beautiful species, annual or perennial, are met with in gardens. One species, *L. albus*, which has been long cultivated, is extensively sown in the south of Europe, for forage, for ploughing in to enrich the land, and for the seeds, which form a great article of food in

some districts, their bitterness being removed by boiling.

Lupulin. The active principle of the hop. [Hops.]

Lupus (Lat.). The Wolf. One of the southern constellations, situated on the south of Scorpio.

Lupus. In Pathology, a disease which eats away the parts attacked by it with great rapidity.

Lurcher. A variety of dog, of mongrel descent, probably allied both to the shepherd's dog and to the greyhound. It is usually employed by poachers.

Luscinia. [Nightingale.]

Lusiad. The name given to the great epic poem of Portugal, written by Camoens, and published in 1571. The subject of this poem is the establishment of the Portuguese empire in India. Among all the heroic poets, says Schlegel, either of ancient or modern times, there has never, since the Homeric age, been any one so loved or honoured by his countrymen as Camoens. It seems as if the national feelings of the Portuguese had centred and reposed themselves in the person of this poet, whom they consider as worthy to supply the place of a whole host of poets, and as being in himself a complete literature to his country. Few modern poems have been so frequently translated as the *Lusiad.* Mr. Adamson (*Memoirs of the Life and Writings of Camoens*) notices one Hebrew translation of it, five Latin, six Spanish, four Italian, three French, four German, and two English. Of the two English versions, one is that of Sir R. Fanshawe, written during Cromwell's usurpation, and distinguished for its fidelity to the original; the other is that of Mickle, who, unlike the former, took great liberties with the original, but whose additions and alterations have met with great approbation from all critics—except, as indeed was to be expected, from the Portuguese themselves. (*Quarterly Review,* vol. xxvii.)

Lustration (Lat. lustratio). A purification by washing or sprinkling with water. Among the Greeks it followed the commission of some crime, which it was to expiate. With the Romans it was simply an act to win the favour of the gods; as on fields after the crops were sown, and on armies before beginning a campaign. A general lustration of the Roman people, called also *lustrum* (from *luo,* the Greek *λούω, I wash*) was held by the censors, at the end of every period of five years, when a sacrifice was offered up, called Suovetaurilia (i. e. the offering of a pig, sheep, and ox). Hence the word *lustrum,* as signifying the time between two such lustra or days of purification, came to be used for the exact space of five years.

Lustrum. [Lustration.]

Lusus Naturae (Lat. *a sport of nature*). A term applied to anything unnatural in the physical world.

Lute (Ital. liuto, derived by Mr. Wedgwood from the Arabic *el ud*). A musical stringed instrument of the guitar species, and played in a similar way; but in form more resembling the section of a pear, with a back in ribs, like those of a melon.

Lute Composition (from Lat. lutum, *moist earth*). A mixture applied to the bungs of powder-cases to keep them air-tight. It consists of fourteen parts of tallow, and six of beeswax, melted together. When cold, it becomes hard, and must be beaten till soft before use.

Clay forms the basis of many lutes; and among other substances employed in lutes may be mentioned borax, moistened bladder, linseed meal, and caoutchouc.

Luteoline and **Luteoleine.** Peculiar colouring principles, obtained from *weld.*

Lutes (Lat. lutum, *moist earth*). Under this term, a variety of compounds are used for securing the junctures of vessels, or protecting them from the action of heat. Slips of wetted bladder; linseed meal made into a paste with gum-water; white of egg and quicklime; glazier's putty, which consists of chalk and linseed oil; and *fat lute,* composed of pipeclay and drying-oil, are useful for retaining vapours; but to withstand the action of a high temperature earthy compounds are required. Loam, or a mixture of clay and sand well beaten into a paste and then thinned with water, and applied by a brush in successive layers to retorts, tubes, &c., enables them to bear a high temperature; if a thick coating is required, care should be taken that the cracks are filled up as the lute dries; a little tow mixed with it renders it more permanent. If the lute is intended to vitrify, as, for instance, to prevent the porosity of earthenware at high temperatures, a portion of borax, or of red lead, may be mixed with it.

Lutherans. The denomination of Christians whose religious system had its origin in the preaching of Luther. This system in some respects approaches nearer to Romanism than that of any other of the reformed churches. The notions of Luther upon the nature of the Eucharist are known under the name of *consubstantiation,* or the coexistence of the body and bread, the blood and the wine, at the same time. It encourages also the private confession of sins, makes use of wafers in the administration of the Lord's Supper, and allows of images in churches. It insists, however, very strongly upon Luther's cardinal doctrine, the justification of man by faith, and not by any merit in human actions. With respect to the divine decrees, it holds that God foreknows the dispositions of men, whether they will be good or bad, and predetermines their salvation or rejection accordingly; differing therein from the tenet of the Calvinists, which represents the Supreme Being as making His decrees by His own mere will. The dogmas of the Lutheran church are carefully set forth in various symbolic books: the *Confession of Augsburg,* the *Articles of Smalcald,* the *Shorter and Larger Catechisms* of Luther, and the

Form of Concord. The principle, however, of this church, which considers Christians as accountable to God alone for their religious opinions, allows its teachers, at the present day, an unbounded liberty of dissenting from these decisions. The Lutheran church predominates in the north of Germany, in Prussia, Norway, Denmark, and Sweden: there are congregations also of the same denomination in England; Holland, Russia, and America. In the Prussian dominions it has been remodelled in modern times, and is called the Evangelical Church. [CHRISTIANITY.]

Lutra (Lat. *an otter*). A genus dismembered by Storr from the Linnæan *Mustela*, and now raised to the rank of a family (*Lutridæ*).

Luxation (Lat. luxare, *to put out of joint*). A dislocation of a bone.

Luz. The name of a bone in the human body, celebrated in Rabbinical writings, and supposed to be indestructible; according to some, it was a vertebra; according to others, it was the sesamoid bone of the great toe, or one of the triangular bones near the lambdoidal suture of the cranium. It is also regarded as the *os sacrum* or penultimate segment of the skeleton of man.

Lycanthropy (Gr. λυκανθρωπία, from λύκος, *a wolf*, and ἄνθρωπος, *a man*). Herodotus relates that the Neurians, a Scythian tribe, were supposed to be changed, for a certain number of days every year, into wolves, and then to resume their former shape; and a similar superstition is noticed by Virgil in his *Eclogues*, by Pliny, Pausanias, and other writers. The same superstition, of the power possessed by men of converting themselves into wolves, remained in more modern times; but that which the classical ancients believed to be effected by the power of herbs, or by innate powers, was by Christians considered as a species of sorcery. These human wolves were called *loup-garoux* by the French, *were-wolves* by the Anglo-Saxons, *wehrwölfe* by the Germans: words of the same derivation, showing that the superstition in those countries was of Teutonic origin. They were believed to be extremely ferocious, and to devour not only beasts, but human beings; but if they were pursued and wounded, the spell was frequently dissolved, and the sorcerers were found mutilated in those limbs in which they had received the wound in their wolfish shape. From the prevalence of these superstitions in the minds of an ignorant peasantry originated the hideous species of madness termed *lycanthropy*, in which the patient believed himself to be a wolf, and frequently imitated the actions and howl of that animal. In France, in the sixteenth century, numbers of these unfortunate beings were executed, like witches, on their own confession. Some of these maniacs declared that they were actually wolves, but that their hair grew inside, or between the skin and the flesh. Oribasius, who lived in the fifth century of our era, mentions lycanthropy as a species of madness, and describes its symptoms and the cure. This species of insanity seems to have gradually died away along with the superstition which gave it birth. (Lecky, *History of Rationalism*, ch. i.)

Lycaon (Gr. Λυκάων). In Greek Mythology, a son of Pelasgus, who is said to have first civilised Arcadia, and to have built the town of Lycosura. The number of his sons is given as twenty-two or fifty; their impiety led Zeus to visit them in the guise of an old man, and when they placed before him a meal of human flesh, they were by him, according to Pausanias, changed into wolves; but Apollodorus (iii. 8. 1) merely says that they with their father were killed by a thunderbolt. This legend is simply an attempt to account for a name the true meaning of which had been forgotten. Thus the name of Arcas, the eponym of Arcadia, belongs to the same root with Arctos, Arcturus, a constellation, of which the Sanscrit name Rishi, *wise-men*, was a corruption of Riksha, *a shiner*. Callisto, the daughter of Arcas, is likewise said to have been turned into a wolf by the wrath of Hera. The mistake arose by the confusion of the Greek word λύκος, *a wolf*, with λευκός, λύκιος, &c., words signifying *light*, and akin to the Latin lux, luceo, lucina, luna, &c.

Lyceum (Fr. Lycée). In France, establishments for secondary instruction, created by the state, were so termed at the time of the Revolution and down to 1814, when the name *collége* was substituted. Since 1848, the name has been revived. In 1858 there were seventy lyceums. The payment to be made by the children is fixed by laws made in 1853 and 1857, and varies according to the classes or *divisions*, of which there are three: elementary, of grammar, superior. A *pensionnaire* in a lyceum at Paris pays 950, 1,050, 1,150 francs per annum in these three classes respectively. There are also *demi-pensionnaires*, and *externes* or day-boarders.

Lychnites. An ancient name of marble, from Gr. λύχνος, its quarries being worked by lamp-light.

Lycium (from Lycia in Asia Minor, its native country). A genus of *Solanaceæ*, one of which, *L. barbarum*, a scandent plant frequently seen on walls and cottages, is often called the Tea-plant, its leaves being recommended as a substitute for tea.

Lycoperdon (Gr. λύκος, and πέρδομαι). A genus of Fungi, to which the name Puffball is given, from their globular form, and from the fact that when they are ripe a blow causes the spores to fly out like a puff of smoke. They are abundant in many places. *L. Bovista*, when young, if cut into slices and fried, is one of our best cooking funguses. The dry mass of threads and spores in the mature plant may be used as a styptic; and the fumes are used for stupefying bees.

Lycopersicum (Gr. λυκοπερσικόν). The Solanaceous genus which yields the Tomato, distinguished from *Solanum*, with which it was

ormerly united, by the anthers being connected with a thin membrane prolonged upwards, and by their cells opening by a long slit instead of by two pores at the top. The Tomato or Love Apple, *L. esculentum*, is an annual plant, native of South America, and long introduced into most warm or temperate countries, where it is cultivated for the sake of its wholesome fruit, which, either green or ripe, is eaten in various ways.

Lycopodiaceæ (Lycopodium, one of the genera). A natural order of Acrogens, inhabiting all parts of the world, but abounding chiefly in hot humid situations. They are intermediate, as it were, between Ferns and *Coniferæ* on the one hand, and Ferns and Mosses upon the other. *Lycopodium rubrum* is a violent cathartic; *L. clavatum* and *Selago* excite vomiting; and the powder contained in the seed-vessels of all the species is so highly inflammable as to be employed occasionally in the manufacture of fireworks. They are propagated by spores formed in two-valved cases axillary to the upper leaves.

Lycopodium. A fine yellow dust or powder, being the seed of the *Lycopodium clavatum*, or Club Moss: when thrown into the flame of a candle, or of spirit of wine, it burns with a bright flash. It is used for producing theatrical lightning, and is an excellent substance to sprinkle upon pills to prevent their adhering.

Lycosa (Gr. λύκος). A genus of spiders, in which the eyes form a quadrilateral group, as long as or longer than it is wide; the two posterior eyes not placed on an elevation. The first pair of legs is evidently longer than the second, but shorter than the fourth, which is the shortest of all. The internal extremity of the jaws is obliquely truncated. Almost all the *Lycosæ* keep on the ground, where they run with great swiftness. They inhabit holes in the ground, which they line with silk, and enlarge in proportion to their growth. Some establish their domicile in chinks and cavities in walls, where they form a silken tube, covered externally with particles of earth or sand. In these retreats they change their tegument; and, as it appears, after closing the opening, pass the winter in a state of torpidity. The females, when they go abroad, carry with them their eggs enveloped in a cocoon attached to the abdomen by threads. On issuing from the egg, the young ones cling to the body of the mother, and remain there until they are able to provide for themselves. The *Lycosæ* are extremely voracious, and courageously defend their dwelling. The famous Tarantula spider is a species of this genus.

Lydian Stone. A silicious slate or flinty Jasper of a velvet-black colour, used as a touchstone for testing the quality of gold and silver.

Lyencephala (Gr. λύω, *I loose*, and ἐγκέφαλος, *brain*). In this, the lowest subclass of the class Mammalia, the name is given from the comparatively loose or disconnected state of the cerebral hemispheres. The size of these hemispheres is such that they leave exposed the olfactory ganglions, the cerebellum, and more or less of the optic lobes; their surface is generally smooth; the anfractuosities, when present, are few and simple.

Lying Panels. In Architecture, the panels in which the fibres of the wood lie in a horizontal direction.

Lying-to. A Nautical term, denoting the state of a ship when the sails are so disposed as to counteract each other, and thereby retard or destroy the progressive motion of the vessel. The fore and main staysails and mizen trysail serve very well for this purpose, as they cause but little way, and have sufficient power to keep the ship heeled over, and therefore steady, with her decks turned from the sea. When the sea runs very high, the lower sails are liable to be becalmed by the waves, and therefore to suffer the ship to roll to windward; the main-topsail is then used.

Lymph (Lat. lympha, *water*). The liquid contained in the lymphatics.

Lymphatics (Lat. lymphaticus). Absorbent vessels, which carry lymph from all parts of the body, and terminate in the thoracic duct.

Lynch Law. The irregular and revengeful species of justice administered by the populace in some parts of the United States is said to have been so called from a Virginian farmer of the name of Lynch, who took the law into his hands on some occasion, by chasing a thief, tying him to a tree, and flogging him with his own hands.

Lynx (Gr. λύγξ). A name given to the different species of a group of the *Cats* (*Felidæ*), distinguished by short tails, and generally tufted ears. The lynxes have been long famed for their sharp sight.

LYNX. A constellation of the northern hemisphere, formed by Hevelius.

Lynx Sapphire or **Luchs Sapphire.** A name given by jewellers to dark greyish or greenish-blue varieties of Sapphire and Iolite.

Lyra (Lat.). A portion of the brain, the under surface of the back of the corpus callosum, the medullary fibres of which are so arranged as to give it somewhat of the appearance of a lyre.

LYRA. The Lyre: one of the forty-eight constellations of Ptolemy. It is situated in the northern hemisphere.

Lyre (Gr. λύρα, Lat. lyra). A musical instrument, of the greatest antiquity, among the Egyptians and Greeks. The Greeks attribute the invention to HERMES [which see]. It is generally considered that the original Egyptian lyre was only of three strings. At a later period the lyre consisted of eleven strings, which were made of the sinews of animals; its body was hollow to increase the volume of tone; and it was played with the *plectrum* or lyre-stick of ivory or polished wood, and sometimes with the fingers like the harp. It went by the different names of lyra, phorminx, barbitos, and cithara.

Lyre Bird or Lyre Pheasant. [MENURA.]

Lyric. [ODE.]

Lythraceæ (*Lythrum*, one of the genera). A natural order of polypetalous Exogenous plants of the Saxifragal alliance. They have long tubular striated calyces, in the orifice of which are inserted the petals, while the stamens grow nearly at the base. They are little known in cultivation; but some of them, belonging to the genera *Lagerströmia, Diplusodon, Lafoensia*, &c., are objects of striking beauty. The Tulipwood of the cabinetmaker is the trunk of *Physocalymna floribunda*, and the Henna, employed in the toilet of Oriental ladies, is obtained from *Lawsonia inermis*.

M

M. The labial letter of the liquid series. It is susceptible of various interchanges, more especially in the Greek and Latin languages. In writing two M's successively, the Germans frequently drop one, and replace it by a stroke over that which they retain; thus, $\bar{m}$. As an abbreviation, M stands for Marcus, Manlius, Martius, and Mucius; M.A. for Magister Artium, MS. for Manuscript, and MSS. for Manuscripts. M, or, more properly, a symbol somewhat resembling it, was used by the Romans to denote 1,000; and the moderns have also adopted that letter.

M. In Medical prescriptions, M stands for *misce*, or mix; also for *manipulus*, a handful.

Mab. The name given by the English poets of the fifteenth and succeeding centuries to the imaginary queen of the fairies. The passage in *Romeo and Juliet*, in which her qualities and attributes are set forth, is familiar to all.

Mac. A Scotch term, signifying *son*, prefixed to many surnames, as *Mac* Donald, &c. It is synonymous with *Fitz* in England, and *O* in Ireland.

Macacus. A genus of Catarrhine or Old World monkeys, characterised by having a fifth tubercle on their last molars; ischial callosities and cheek pouches; comparatively short and thick limbs; a projecting muzzle and prominent superciliary arches. They have generally a pendent tail; but in some it is short, as in the pig-tailed baboon (*Macacus Rhesus*). When they cry out, they inflate a membranous sac, which communicates with the larynx above the thyroid cartilage.

Macadamising. A method of making roads, introduced by Sir J. Macadam, which consists in placing stones, broken into fragments, on a convex surface. The road ought to be completed by passing a very heavy roller over it, and this is enforced in Paris; but in London the work of smoothing down the broken stones is left to be completed by the carts and carriages which pass over it, greatly to their detriment, and to the profit of the contractor.

Macaroni. [VERMICELLI.]

Macaronic Verse. Verse in which the words of a modern language are ludicrously distorted into Greek or Latin inflections and metre. Theophilo Folengo, who wrote under the name of Merlinus Coccaius, in Italy, in the sixteenth century, and calls himself the inventor of this sort of burlesque composition, informs us that its name is derived from the Italian macaroni, eatables composed of flour, cheese, and butter; and that it expresses the gross and rustic characters appropriate to its words and sentiments. Drummond's *Polemo-Middinia*, a Scottish burlesque, is perhaps the best known macaronic form of our language. See the learned work of Mr. Delepierre on *Macaroniana*.

Macaw. A term applied to those parrots (*Macrocercus*) which are distinguished by the greater length of tail, and by the greater brilliancy of their colours.

Maccabees, Books of the. The last two books in the arrangement of the Apocryphal writings enumerated in the sixth article of the church of England. The first is a Greek translation (as is supposed) from a Chaldaic original. The second appears to be a compilation from various sources. The two books are not connected; the former comprehends the events of Jewish history for nearly 40 years, B.C. 176 to 139; the second begins about B.C. 187, and extends over about 16 years. Neither has ever been reckoned by the Jews in their catalogue of sacred writings; but they are received into the canon of Scripture by the church of Rome, with the title of *3rd and 4th Chronicles*. There are two other books, commonly called *3rd and 4th Maccabees*, which were never received by any church.

Mace (Ital. mazza, *a club*; Fr. masse; Lat. massa; Gr. μάζα). A club of metal used as a military weapon from the most remote times. About the period of Edward II. maces were generally used in England, both in battles and tournaments; and they remained in use till the time of Elizabeth, when they appear to have been displaced by the pistol. Maces are still used by the Turkish cavalry. The mace, as an ensign of authority, is often borne before magistrates. By the old English writers it is used synonymously with sceptre. It was invariably the distinguishing weapon of a sergeant-at-arms.

MACE, the external envelope of the seed of the nutmeg, is a particular form of what botanists call *arillus*. It is an agreeable aromatic, and is chiefly used in cookery or in pickles.

Macedonians. In Ecclesiastical History, a sect which derives its name from a bishop

of Constantinople, who, in the fourth century, denied the distinct existence and Godhead of the Holy Spirit, which he conceived to be merely 'a divine energy diffused throughout the universe,' 'while the Father and Son together constitute the one existing Deity.' These opinions were condemned at the second general council held at Constantinople in 381. [PNEUMATOMACHI.]

Macer. The bark of the root of a tree growing in Malabar. It is astringent, and celebrated for the cure of diarrhœa.

Maceration (Lat. maceratio, *a soaking*). The steeping of substances in any cold liquor.

Machairodus (Gr. μάχαιρα, *a sabre*, and ὀδούς, *a tooth*). An extinct mammal, allied to the existing Felidæ, in which the upper canines were much elongated, trenchant, sharp-pointed, and sabre-shaped. Species varying from the size of a lion to that of a leopard have been found in miocene, pliocene, and cave deposits in Auvergne, Eppelsheim, Val d'Arno, Devonshire, the Pampas, Brazilian bone caves, and the Sewalik tertiaries of India.

Machetes (Gr. μαχητής, *a combatant*). The generic name under which Cuvier has distinguished the ruffs and reeves from the sandpipers, godwits, and other allied Grallæ. The ruffs have the bill and carriage of the genus *Calidris*; but the membrane between their external toes is nearly as extensive as in *Limosa*. Our native species (*Machetes pugnax*, Cuv.) is somewhat smaller than a snipe, and celebrated for the furious combats that take place among the males in their nuptial season. At this period the head is partly covered with red papillæ; the neck is surrounded with a thick collar of feathers, which often varies in different individuals.

Machiavelism. A name given to the system of governing propounded in the general writings of Machiavelli, and particularly in his treatise called *The Prince*. The term is still used in a disparaging sense, notwithstanding the different construction which has of late been given to the motives and purposes for which Machiavelli wrote his work.

Machicoulis (Fr.). A system of holes between the corbels supporting a gallery or balcony projecting from the top of a wall or tower, through which missiles can be thrown upon the heads of an enemy below. A building thus fortified is said to be *machicolated*.

Machine (Gr. μηχανή). In a general sense, this word signifies anything which serves to increase or regulate the effect of a given force. Machines are either *simple* or *compound*. The simple machines, otherwise called the *simple mechanical powers*, are usually reckoned six in number; namely, the LEVER, the WHEEL AND AXLE, the PULLEY, the WEDGE, the SCREW, and the FUNICULAR MACHINE [see the respective terms].

Compound machines are formed by combining two or more simple machines. They are classed under different denominations, according to the forces by which they are put in motion, as *hydraulic* machines, *pneumatic* machines, *electrical* machines, &c.; or the purposes which they are intended to serve, as *military* machines, *architectural* machines, &c

Although there are no limits to the combinations and adaptations of machinery, there are certain general principles which may be applied in estimating the effects of any machine whatever. When a machine attains its state of uniform motion, the momentum of the power is equal to that of the resistance, and is the same that would be in equilibrio with the resistance if there were no motion at all. From this principle, and from the consideration that in all machines the work done is to be estimated not merely from the quantity of resistance which is overcome, but from the quantity overcome in a given time, we can ascertain the relation that ought to subsist between the velocity and the load or resistance in order that the effect of the machine may be a maximum. This maximum effect is produced when the two following conditions are fulfilled: 1. When the load, or resistance, is about four-ninths of that which the power, when fully exerted, is just able to balance, or that which would keep the machine at rest altogether; and, 2. When the velocity of that part of the machine to which the power is applied is one-third of the greatest velocity of the power. These conditions are deduced from the following empirical expression, which is adopted by Euler and other writers to represent the law of the moving power. Let $P=$ the power applied (or weight which the power, when fully exerted, is just able to overcome); $R=$ the resistance, or load, or weight to be overcome; c the greatest velocity, or that at which the power ceases to act; $v=$ any other velocity: then the law of the moving power is

$$R=P\left(1-\frac{v}{c}\right)^2$$

The variables in this expression are R and v, and the effect is represented by the product Rv; on making which a maximum, the rules of the differential calculus give $v=\frac{1}{3}c$; whence the formula becomes $R=\frac{4}{9}P$.

From these expressions it follows, that when the moving power and the resistance are both given, if a machine be so constructed that the velocity of the part to which the power is applied is to the velocity of the part to which the resistance is applied in the ratio of 9 R to 4 P, the effect of the machine will be a maximum; in other words, it will work to the greatest possible advantage. The above conditions apply equally to machines impelled by animal force and the agents of nature, as running water, steam, the force of gravity, &c. An animal exerts itself to the greatest advantage, or performs the greatest quantity of work in the least time, when it moves with about one-third of the utmost speed with which it is capable of moving, and is loaded with four-ninths of the greatest load which it is

capable of putting in motion. It has been supposed in the above remarks that the friction of the parts of the machine is included in the resistance. (Coriolis, *De l'Effet des Machines*; Navier, *Leçons sur l'Application de la Mécanique*; Belidor, *Architecture Hydraulique*; Gregory's *Mechanics*; Moseley's *Mechanics applied to the Arts*; &c.)

Machine, Calculating. [CALCULATING MACHINE.]

Machine, Printing. [PRINTING.]

Macigno (Ital.). A hard silicious sandstone.

Mackerel. A well-known European and American fish, of which the body is spindle-shaped, smooth, beautifully coloured, and with small scales. It is distinguishable for the rapidity with which it dies out of the water, and for the facility with which it becomes tainted. [SCOMBER.]

Maclaurin's Theorem. In Mathematics, a theorem by which, whenever possible, a function may be developed in a series proceeding according to ascending powers of the independent variable. It is a particular case of TAYLOR'S THEOREM, and was given by Maclaurin in his *Treatise on Fluxions*, Edinburgh 1742, though it had been previously noticed by Stirling. It may be thus expressed:

$$F(x) = F(o) + F^{1}(o)\frac{x}{1} + F''(o)\frac{x^2}{1.2} + \ \ldots\ldots$$

$$F^{(i)}(o)\frac{1}{1.2\ \ldots\ i} + R_i,$$

where $F^{(i)}(x)$ is the i^{th} derived function of $F(x)$, and $F^{(i)}(o)$ its value when $x = o$. The remainder R, which it is necessary to consider in all cases, has the value

$$R_i = F^{(i+1)}(\theta x)\frac{x^{i+1}}{1.2\ \ldots\ (i+1)},$$

where θ is some proper fraction. The equivalent form, as given by Cauchy, would be

$$R_i = F^{(i+1)}(\theta_1 x)\,\frac{(1-\theta_1)^i x^{i+1}}{1.2\ \ldots\ i_1},$$

or, expressed as a definite integral,

$$R_i = \frac{1}{1.2\ \ldots\ i}\int_0^x z^i F^{(i+1)}(x-z)\,dz.$$

The series breaks off at the $(n+1)^{th}$ term when $F(x)$ is a rational integral function of the n^{th} degree, and to be valid the theorem requires that neither $F(x)$ nor any of its derivatives shall become infinite for the values of x under consideration.

Macle. A mineral; called also CHIASTOLITE [which see]. It forms prismatic crystals, white externally and grey within, which are found embedded in clay-slate. Its principal component parts are silica and alumina, with a little oxide of iron.

Macles or Twin Crystals. [CRYSTALLOGRAPHY.]

Maclureite. A mineral from New York and New Jersey, named after Dr. Maclure. It occurs in roundish embedded masses, imperfectly crystalline. It is a silicate of magnesia, with traces of potash, oxide of iron, and fluorine.

Macmillanites. A religious sect in Scotland, the successors and representatives of the Covenanters in the seventeenth century. On the first settlement of presbytery as the established church of Scotland at the Revolution in 1688, a small body of the people condemned the principles on which that act was founded as Erastian. They insisted that the church, though endowed by the state, should be entirely independent of civil authority, and uncontrollable and supreme in itself. Though reduced to a very small number, they maintained their principles with unshaken firmness, and would accept of no conditions of which these were not the basis. They also continued zealously to maintain those praying societies (hence they were sometimes called *Society people*) which they had formed in the time of Charles II. They remained without a pastor for sixteen years. Meanwhile, John M'Millan, who had been ordained parochial minister of Balmaghie, in the stewartry of Kirkcudbright, in 1701 adopted and publicly avowed their principles; and was, in consequence, deposed in 1704. He did not, however, renounce his ministerial character; but continued to officiate both among his former people, who almost to a man adhered to him, and others who favoured his views. In 1706, having received a unanimous call from the scattered societies to be their minister, he accepted the invitation; and in a short time he was joined by John M'Neil, a licentiate of the established church. The veneration which M'Millan and M'Neil entertained for presbyterian government, prevented any attempt being made to obtain ordination for the latter in an irregular way. Neither would they compromise their principles to gain the co-operation of other ministers who, for somewhat different opinions, had been expelled from the establishment. They renewed the Covenant in 1712, and never ceased to bear public testimony against what they regarded the defections and corruptions of the church of Scotland. On the death of M'Neil, which took place not long afterwards, M'Millan was joined by the Rev. Thomas Nairn. The prospects of the *M'Millanites*, as this sect had long been called in honour of their leader, now began to brighten. Their two clergymen and some lay elders (formerly ordained) constituted a presbytery, in 1743, at Braehead, near Carnwarth, Lanarkshire, and gave their body the name of the Reformed Presbytery—a designation which has superseded, in a great measure, that of M'Millanites. They are also called *Mountain* or *Hill people*; because, having at first no chapels, they conducted public worship, in imitation of their persecuted ancestors, in the open air, generally on the side of a hill. (Adams's *Religious World Displayed*, vol. iii. 157–169; *The Testimony of the Reformed Presbyterian Church*, Paisley 1837: *Historical Part of the Testimony*, Glasgow

1839; *A Short Account of the Old Presbyterian Dissenters*, Glasgow 1824; *Acts of Gen. Assem. apud Ann.* 1704, 1708, 1715.) [CAMERONIANS; COVENANTERS.]

Macquer's Salt. A Pharmaceutical designation of the binarseniate of potassa.

Macrauchenia (Gr. μακραύχην, *long-necked*). A genus of colossal Perissodactyle (three-toed) Mammalia, which exhibits the character peculiar to the existing Camels and Llamas, of having the cervical vertebra not perforated by the usual arterial foramina. Its fossil remains have been found in Patagonia and Bolivia.

Macrocosm (Gr. μακρός, *large*; κόσμος, *world*). A term applied to the world at large, or *universe*, as opposed to *microcosm*, having reference to man.

Macrodactyli (Gr. μακροδάκτυλος, *long-fingered*). A tribe of wading birds, comprehending those in which the toes are remarkable for their extreme length; as the jacanas.

Macromyelon (Gr. μακρός, and μυελός, *marrow*). A term for the MEDULLA OBLONGATA [which see].

Macropiper (Gr. μακρός, *long*, and Lat. piper). The Ava or Kava root of the Polynesians is furnished by a species of this genus, *M. methysticum*, a shrubby plant, with knotty stems, cordate leaves, and axillary spikes of flowers. The leaf has narcotic properties, and is employed medicinally; but its most important use is to supply the narcotic stimulant beverage called *kava*, of which the natives partake before they engage in any important business, or any religious rites. The Kava is prepared by chewing the root of the plant, and thus extracting the juice, which is afterwards collected.

Macropus (Gr. μακρόπους, *long-footed*). The generic name of the kangaroo; also applied to a genus of beetles.

Macrotherium (Gr. μακρός, and θηρίον, *a beast*). A genus of Bruta, which was originally founded on a single ungual phalanx, discovered in the miocene deposits at Eppelsheim. The conclusions of Cuvier, drawn from an examination of this toe-bone, were, that it belonged to an animal allied to the existing Pangolin (*Manis*), and this induction has been verified by the discovery of similar bones, in deposits of the same age at Sansan, in the South of France. The discovery of two molar teeth, the humerus, ulna, and femur, leads to the conclusion that it also offered much analogy to the existing *Orycteropus*.

Macrourans (Gr. μακρός, and οὐρά, *a tail*). A section of Decapod Crustaceans, including all those which have the tail, or post abdomen, as long or longer than the body.

Mactra. A Lamarckian genus of bivalve shells, in which the ligament is attended on both sides with a lateral tooth which locks within two laminæ of the opposite valve.

Maculæ (Lat. *spots*). Dark spots on the surfaces of the sun and moon, and on some of the planets. The solar spots are very variable as to form and continuance. They were first observed by Galileo in Italy, and Harriot in England. [MOON; SUN.]

Madame, Mademoiselle (Lat. mea domina, *my mistress*). The titles given by French etiquette to married and unmarried ladies respectively. The latter, in the strict usage of the old régime, belonged more especially to the eldest daughter of a brother or uncle of the reigning king. Thus the daughter of Gaston of Orleans is described as 'Mademoiselle,' in the writings of the period of the Fronde. For the history of the word, see Max Müller, *Lectures on Language*, first series, vi.

Madarosis (Gr. μαδαρός, *melting away*). A falling off of hair, especially of the eyelashes.

Madder, Colouring Matters of. Madder, *Rubia tinctorum*, grows naturally in the south of Europe, and is largely cultivated in Holland. Its tinctorial power exists in the woody portion of its roots. This fibrous matter is met with in commerce under the name of *lizari*, or *alizari*, or, if ground, under that of *garance*. It is an article of large consumption with dyers and calico printers, and is used in the production of all shades of red, purple, brown, and even black. *Rubian* is, according to Schunck, the chief colour-producing agent in madder-root. It is itself almost colourless, but by action of air under the influence of a ferment, *erythrozym*, contained in the root, it splits up into *alizarin*, the true madder colour, and grape sugar: these are accompanied by secondary yet definite crystalline compounds, namely, *rubiretin*, *verantin*, *rubiafin*, and *rubiagin*. Under the influence of acids it yields most of the above compounds, and in addition *rubianin*, and by alkalies *rubiadin*. *Purpurin* accompanies, and is possibly only a variety of *alizarin*. *Rubiacin* is a yellow colouring matter, and *chlorgenin* a green pigment contained in madder. Madder colours are persistent under the influence of air and light, and are easily fixed by mordants. [RUBIACEÆ.]

Madia (Gr. μαδός, *bald*). A genus of Composite plants, of which the only species, *M. sativa*, a native of Chili and North California, is there cultivated for the oil extracted from its fruits.

Madonna (Ital. *my lady*, for Lat. mea domina). An Italian term applied to the Virgin Mary. Hence pictures of the Italian school representing the Virgin are generally designated as *Madonnas*. [MADAME.]

Madrepora (Fr. madrepore). The word appears to have been first used by Imperati to designate a genus of Lithophytes, in which the calcareous axis has its whole surface beset with small lamellate and stellate depressions.

The genus was adopted by Linnæus, who placed it among his *Vermes Zoophyta*, and characterised it as follows: '*Animal* resembling a medusa; *coral* with lamellate star-shaped cavities.' It is scarcely necessary to observe that the animal, especially in the larger madrepores, as the *Fungia*, most closely resembles the *Actinia* in its general organisation. Cuvier

places the madrepores in the tribe *Lithophyta*, of the family of *Polypi corticati*. The Lithophytes having the common character of the Linnæan genus are now subdivided into the genera *Fungia*, Lam.; *Turbinolia*, Lam.; *Cyclolythus*, Lam.; *Caryophyllæa*, Lam.; *Oculina*, Lam.; *Pœcilopora*, Lam.; *Serialopora*, Lam.; *Astrea*, *Explanaria*, *Porites*, *Meandrina*, Cuv.; *Pavonia*, Cuv.; *Hydrophora*, Fischer; *Agaricina*, Cuv.; *Sarcinula*, Lam.; *Stylina*, Cuv.; and *Madrepora* proper.

Madreporite. A species of columnar carbonate of lime, found in Norway and Greenland.

Madrier (Fr.). In Military Engineering, a thick plank covered with plates of iron, and having a cavity sufficient to receive the mouth of a petard, with which it is applied against a gate or any other obstacle intended to be broken down. Also, the flat beams laid in the bottom of a moat or ditch to support the wall. There are also madriers lined with tin and covered with earth, to form roofs over certain portions of military works, in order to afford protection against fires in lodgements, &c.

Madrigal (Ital. madrigale). One of the lesser kind of poems, usually consisting of fewer verses than the sonnet or roundelay. In its composition the fancy and convenience of the poet are not subjected to very strict rules, rhymes and verses of different species being often intermixed. The subjects are mostly of a tender and gallant nature; the character often quaint, the expressions marked with great simplicity. Sometimes, however, a loftier and sublimer train of thought finds its way into these compositions, especially among those of the English school, as in the following celebrated specimen, set to music, and perhaps written, by Orlando Gibbons, in 1612:—

Oh! that the learned poets of this time,
Who in a lovesick line so well can speak,
Would not consume good wit in hateful rhyme,
But with deep care some better subject find;
For if their music please in earthly things,
How would it sound if strung with heav'nly strings!

Of a lighter and more regular sort, the following may serve for a specimen:—

When Thoralis delights to walk,
  The fairies do attend her;
They sweetly sing and sweetly talk,
  And sweetly do commend her.
The satyrs leap and dance around,
  And make their congés to the ground;
And evermore their song is this,
'Long may'st thou live, fair Thoralis!'

In a musical sense, a madrigal is a vocal composition in several parts, in antique figured contrapuntal style, and intended to be sung by many voices to each part.

Simple madrigals appeared about the beginning of the sixteenth century, during which, and the whole of that following, the style was particularly cultivated and encouraged. The fashion may now be considered to have passed away, unless we are allowed to consider the English glee an offset from it. The first madrigals were in a style of music very much resembling that of the church; but they afterwards assumed a character peculiar to themselves, which is strikingly exemplified in those of Luca Marenzio (soon after the time of Palestrina), and after him in the works of Gesualdo, the prince of Venosa, Monteverde, and Mazocchi. It is in their madrigals that the restraints which laboured counterpoint imposed were abandoned, to make way for imitations, canons, and fugues. The style was indeed that of the age, but the subjects were free; and the tender and impassioned poetry adopted was well expressed in the affections of the harmonies employed. The original character gradually became more free, and was carried to its utmost limit in the compositions of the celebrated Alessandro Scarlatti. In England, during the reign of Elizabeth, the composition of the madrigal attained a very high, perhaps the highest, degree of excellence. Our composers were in no respect inferior to those of Italy and the Netherlands, and among them are to be found the names of Orlando Gibbons, Dowland, Wilbye, Ward, Bennett, and Morley.

Maestoso (Ital.). In Music, a direction to the performer that the music to which the word is prefixed is to be performed majestically and with grandeur.

Maestricht Beds. The neighbourhood of Maestricht contains some beds belonging to the chalk, but apparently newer than any part of that rock in England. Of these beds the upper part is coralline, and the lower chert. None of the deposits exactly resemble chalk. Some of the fossils are unquestionably cretaceous, and others are quite distinct from those found in English cretaceous rocks, and indeed more nearly resemble those of the oldest tertiaries. At Faroe, in Denmark, beds occur newer than English chalk; and a mass of yellowish pisolitic limestone overlies the chalk in France, near Paris, quite unconformably, and is probably of much newer date, though not tertiary. None of these beds are yet found in England, where perhaps the denudation has been more complete.

These newer deposits must not be confounded with the true chalk of Maestricht, which is of the ordinary kind, and has yielded some remarkable fossils; among the rest, part of the skull of a reptile, of large size, called *Mosasaurus*. The cretaceous beds of Western Europe cannot anywhere be regarded as affording passage beds to the older tertiaries.

Magazine (Fr. magasin; Span. magacen, perhaps an Arabic word). A receptacle for military stores, but especially for gunpowder. Magazines in a fortress should always be made shell-proof.

Magazine. An apartment in the hold of a ship in which the powder is kept. As lights are not allowed to be burnt here, the light is received from an adjoining apartment, called *the light-room*, through a transparent screen. The principal magazine is in the forehold, but there is usually a small service magazine in

the afterhold. There are appliances for flooding either magazine on the least appearance of fire in its vicinity.

MAGAZINE. In Literature, the general designation for the periodical literature of a country, exclusive of the newspaper and review. The peculiar province of the two latter seems to be to give information—the one on politics and passing events, the other on literary and scientific subjects; while that of the magazine is of a more miscellaneous character, embracing all the features of the newspaper and review, but at the same time containing, in the form of tales, sketches, and poetry, &c., a great variety of what may be termed *original* matter, the introduction of which would be foreign to the purposes of the others. The earliest publication of this kind in England was the *Gentleman's Magazine*, which still exists. It appeared in 1731, and the success which followed its establishment immediately called into the field a host of competitors, which have so increased in number and variety as to form an era in literary history. [PERIODICALS; REVIEW.]

Magdeburg, Centuriators of. [CENTURIATORS OF MAGDEBURG.]

Magdeburg Experiment or Hemispheres. A hollow sphere composed of two hemispheres which fit air-tight, intended to show the amount of the air's pressure, by the amount of force with which they are held together after the interior air has been removed by the air-pump. This apparatus was first suggested by Otto Guericke, of Magdeburg, the inventor of the air-pump.

Magellanic Clouds. Two nebulæ in the southern hemisphere, first recorded by the navigator Magellan, and named after him. These singular objects were carefully examined by Sir John Herschel during his residence at the Cape of Good Hope from 1834 to 1838, and are minutely described in his *Results of Astronomical Observations*, &c. The greater nebula, or *Nubecula major*, is situated between the meridians of 4 h. 40 m. and 6 h. 0 m., and the parallels of 156° and 162° of North Polar Distance, occupying an area of about 42 square degrees. The lesser, *Nubecula minor*, is situated between the meridians 0 h. 28 m. and 1 h. 15 m., and the parallels of 162° and 165° N.P.D., and covers about ten square degrees. Their general shape is round, or somewhat oval; and the larger, which deviates most from the circular form, exhibits the appearance of an axis of light very ill defined, and by no means strongly distinguished from the general mass which seems to open out at its extremities into somewhat oval sweeps. 'When examined through powerful telescopes,' Sir John observes, 'the constitution of the nubeculæ, and especially of the Nubecula major, is found to be of astonishing complexity. The general ground of both consists of large tracts and patches of nebulosity in every stage of resolution, from light irresolvable with eighteen inches of reflecting aperture, up to perfectly separated stars, like the Milky Way, and clustering groups sufficiently insulated and condensed to come under the designation of irregular, and in some cases pretty rich clusters. But besides those, there are also nebulæ in abundance, both regular and irregular—globular clusters in every state of condensation, and objects of a nebulous character quite peculiar, and which have no analogue in any other region of the heavens. Such is the concentration of the objects, that in the area occupied by the Nubecula major not fewer than 278 nebulæ and clusters have been enumerated, besides fifty or sixty outliers, which (considering the general barrenness of such objects in the immediate neighbourhood) ought certainly to be reckoned as its appendages, being about six and a half per square degree, which very far exceeds the average of any other, even the most crowded parts of the nebulous heavens. In the Nubecula minor the concentration of such objects is less, though still very striking, thirty-seven having been observed within its area, and six adjacent but outlying. The nubeculæ, then, combine, each within its own area, characters which, in the rest of the heavens, are no less strikingly separated—viz. those of the galactic and the nebular system. Globular clusters (except in one region of small extent) and nebulæ of regular elliptic forms are comparatively rare in the Milky Way, and are found congregated in the greatest abundance in a part of the heavens the most remote possible from that circle; whereas, in the nubeculæ, they are indiscriminately mixed with the general starry ground, and with irregular though small nebulæ.' (*Outlines of Astronomy*, p. 613.)

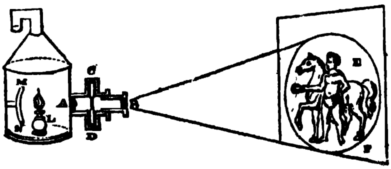
Magenta. One of the red or crimson dyes derived from Aniline.

Magians (Gr. μάγος). The hereditary priests among the Persians and Medians are so termed by ancient Greek historians. The name has been derived by modern orientalists from *mog* or *mag*, signifying priest in the Pehlevi language. Zoroaster is designated as the great reformer of the order; but the history and the very existence of that celebrated character are enveloped in complete obscurity. He is generally supposed to have lived at no long period before the age of Cyrus. The most remarkable feature of his doctrine consisted in the two principles of Good and Evil, which were held to divide the dominion of the world, in alternate periods, during its whole predestined duration of 12,000 years. [DUALISM.] The books termed the *Zendavesta*, brought to Europe in the last century by Anquetil du Perron, are supposed by some to contain the essential doctrines of this religion; but their authenticity has been the subject of much discussion. The fire-worshippers of Persia and India still hold them in reverence. [ZENDAVESTA; GUEBRES.] Our amplest resources for the study of the religion and character of the ancient magi are to be found in the learned researches of Anquetil. (*Mémoires de l'Acad. des Inscriptions*, vol. xxxiv.)

Magic (Lat. ars magica, *the art of the magi*). Common as the superstitious belief in the possession of such powers has been among all nations hitherto discovered on the globe, the Romans were, perhaps, the most superstitious, in this and other respects, of all people. No American tribe has a more implicit faith in its rude 'medicines' or 'mysteries,' than this great and civilised people had in its auguries and divinations; and it is a remarkable feature in their character, that while their religion prescribed these rites, the popular imagination was always searching after fresh excitement from others, which were not only unauthorised, but condemned by their laws—the practices of the Thessalian witches, the magi, the sorcerers of Egypt and Phrygia, and the numberless other foreign nations with which their dominion brought them in contact. Against these the emperors were continually renewing their ineffectual edicts; and it seems to have been mainly from this circumstance that the idea of magic, as a black and forbidden art, became rooted in the minds of the people of modern Europe. For the northern conquerors held such supernatural power in high respect; and in the East, the favourite land of sorcery and magic, the professors have from time immemorial been regarded rather as venerable than as hateful. Hence, if any systematic account can be attempted of matters which have their foundation in the strange caprices of popular credulity, it may be thought that, in the superstition of the middle ages, *white* magic or *celestial* magic, according to Cornelius Agrippa's division, originated in the North or East; *superstitious* or *diabolical* magic from Roman notions engrafted on Christianity; while *natural* magic arose merely from the disposition among the scientific of those days to take advantage of the vulgar propensity to attribute everything extraordinary to supernatural causes. It is to be observed that among the crusaders, and other Christian warriors of the middle ages, magic was regarded as a peculiar ally of the eastern and northern infidels with whom they were in contact. The inhospitable North was peopled by their imagination with enchanted castles and spectral illusions (Scott's *Dæmonology and Witchcraft*, letter v.); and Froissart gives a most picturesque account of the spells which were resorted to by Mohammedan warriors in their conflicts with the soldiers of the cross. In the romances founded on these historical encounters there is usually a good magician or witch (not the degraded witch of vulgar superstition, but the French fée, Italian fata) enlisted in the Christian party; evil necromancers in that of the infidels. Thus, in *Ariosto*, Malagigi and Melissa aid the one side, and Atlas the other. The notion of *white witches*, or beneficent wizards, was assiduously kept up by those impostors who wished to profit by the public credulity, and yet avoid the penalties awarded by the church; and in the church itself there was a contest continually maintained, whether magic, practised through laborious research and study of the celestial influences or intermediate spirits, was lawful. But the public opinion always inclined the other way; and the magicians of highest pretensions were always in danger of being classed with the hated necromancers who derived their power from compact with the devil. Among the earliest fables respecting the higher order of European magicians is that of Virgil, the Latin poet, turned into a wizard by popular belief, which dates as high as the eleventh or twelfth century. Robert of Lincoln (Grossetête), Michel Scot, Albertus Magnus, and the famous Roger Bacon, all lived in the thirteenth. Of these the first was a church reformer, who seems to have lain under the imputation of magic merely on account of the displeasure with which he was regarded by the orthodox. Michel Scot is almost wholly a traditional personage; that is, his real history is scarcely known: the European reputation which he had achieved as a wizard is proved by the high mention of him in the *Inferno* of Dante, who condemns all magicians indiscriminately to endless punishment. It is difficult to say that Roger Bacon ever gave any cause by pretensions of his own, like so many other eminent natural philosophers of early time, to those charges of magic to which his high genius subjected him. Perhaps Sir F. Palgrave, in his amusing fiction (*The Merchant and Friar*), was not far wrong in representing him as partly dazzled by an inability to comprehend the real extent of those extraordinary discoveries which were opening upon him, and partly owing his magical reputation to the impostures practised by his servants in his name. Albertus Magnus, a Dominican, and a celebrated magician in his time, lies more justly open to the charge of quackery. It seems to have been after this time, about the fourteenth century, that magic rose for a season into high repute as a lawful art, and sovereigns had professed magicians and astrologers attached to them. The extraordinary tales related of some of these point evidently to results effected by means of legerdemain; the feats of Ziito, sorcerer to Wenceslas, king of Bohemia (Godwin, *Lives of the Necromancers*, p. 273), are exactly a counterpart of what Tavernier saw at the court of the Great Mogul. The higher order of magicians maintained their pretensions with difficulty after the revival of letters. Yet the three most famous of all belong to the commencement of that era: Doctor Faustus (if that personage be not altogether traditional), Cornelius Agrippa, and Paracelsus. It will, however, be evident to anyone who reads their history, that the belief in *celestial* magic was with difficulty maintained in their days, while that in *necromancy* and *witchcraft* remained almost as strong as ever. There is a good deal of mystery about the character of the famous Dr. Dee; and it does not appear distinctly how far he pretended to those powers which are ascribed to him in that dreary work entitled, *A True*

Relation of what passed between Dr. Dee and some Spirits, published by Meric Casaubon, in 1659. In 1634, the French curate, Urbain Grandier, was burnt for sorcery at Loudun; in 1640, Dr. Lamb was murdered by the London mob; and these are nearly the latest instances of distinguished magicians, while the degraded belief in witchcraft lasted much longer. As to *natural magic*, or the production of singular phenomena by natural means, see Brewster's *Letters on Natural Magic*. [WITCHCRAFT.]

Magic Lantern. An optical instrument, by means of which small figures, painted with transparent varnish on slides of glass, are represented on a wall or screen considerably magnified. It is generally used as a toy, and affords amusement from the grotesque character of the figures; but is also employed to enlarge the diagrams employed in astronomical and other lectures, so as to be seen by an audience: for which purpose it is well adapted, both by its portability and the small cost of the whole apparatus. The principle of its construction is very simple. A lamp L, with a powerful Argand burner, is placed within a closed lantern, and in the focus of a concave mirror M N. At the opposite



side of the lantern is fixed a tube A B, containing a hemispherical illuminating lens A, and a convex lens B; and between A and B is a slit C D, through which the sliders of painted glass are introduced. In this manner the picture is placed in the axis of the tube, and strongly illuminated, in consequence of the light being concentrated upon it by the mirror. The picture being also in one of the conjugate foci of the lens B, an enlarged image of it is formed upon a wall or screen E F at some distance behind. The tube A B is made to pull out, so that the distance of the lens B from the slider can be increased or diminished at pleasure, and consequently an image formed of any size within moderate limits, by increasing or diminishing the distance between the lantern and the screen. The magic lantern was invented by Athanasius Kircher.

Magic Square. A term used to denote a series of numbers in arithmetical progression, arranged in the equal cells of a square in such a manner that the vertical, horizontal, and diagonal columns give the same sum. For example, let the first sixteen numbers be arranged as in the annexed table, and a magic square will be produced; for the numbers in each vertical column, in each horizontal column, and in the two diagonal columns, being added

1	16	11	6
13	4	7	10
8	9	14	3
12	5	2	15

together, give the same sum, namely 34. This is, however, only one of a great number of ways in which the same numbers may be arranged so as to fulfil the conditions. Frenicle (*Divers Ouvrages*, Paris 1693) has shown that there are 878 such arrangements. Emanuel Moscopolus, a Greek author of the fourteenth or fifteenth century, is the first who is known to have treated of magic squares, and to have given rules for their construction. The principal authors who have written on the subject are Stifels, Leibnitz, Bachet, Pojgnard, Lahire, Ozanam, Franklin, &c. For the history of the subject, see Montucla, vol. i. p. 346, or Hutton's *Dictionary*; and for the methods of constructing them, Ozanam's or Hutton's *Mathematical Recreations*.

Magilp. When linseed oil and mastic varnish are mixed together, they produce a gelatinous compound known under the above name, and used by artists as a vehicle for colours.

Magilus. A name given by Montfort to a genus of Tubulibranchiate Gastropods in the system of Cuvier, chiefly remarkable for the form, length, and solidity of their shell. The modifications of this dermal production are due in the present instance, in great measure, to the accidental circumstances of the locality in which the growth of the individual proceeds. The young *Magilus* commences its career in a bed of lithophytous coral, and during the early and rapid stages of its developement secretes its calcareous covering in the ordinary form of a spiral univalve; but the growth of the surrounding madrepore soon surpasses its own, and it is compelled to bring its oral and respiratory orifices, by the most direct route, to the level of the surrounding coral. While this change of place is being effected, the mollusc continues to secrete fresh layers of shell coextensive with its own advance, and to fill up the deserted part of the shell with a solid deposit of a dense, semivitreous, and subtransparent carbonate of lime, and finally produces an elongated, slightly wavy, tubular shell, with the apex sculptured in the form of a spiral univalve, and the opposite end excavated to a certain depth for the lodgement of the animal. The tube is characterised by being longitudinally carinated.

Magister (Lat. contracted Mister or Mr.). An appellation given, in the middle ages, to those persons who had attained some degree of literary or scientific eminence—in scientiâ aliquâ præsertim literariâ. It is given in our universities to those who have taken the highest degree in the Faculty of Arts. It was equivalent to the modern title of doctor.

Magister Equitum (Lat. *master of the horse*). An officer among the Romans subordinate to the dictator, by whom he was usually elected. [DICTATOR.]

Magistery. The old chemists generally applied this term to *precipitates* produced by the dilution of certain solutions with water: such as magistery of *bismuth*, which is an insoluble subnitrate, obtained by pouring nitrate

of bismuth into water; and magistery of *benzoin*, formed by pouring an alcoholic solution of benzoin into water.

Magistral Formulæ. A term applied to extemporaneous prescriptions, as opposed to officinal formulæ, or those ordered in the *Pharmacopœia* and kept ready prepared in the shops.

Magistral Line or **Guiding Line.** In Fortification, usually the line of the top of the scarp of a work.

Magistrate (Lat. magistratus). A general designation of those public officers to whom the executive power of the law is committed, either wholly or in part. Under the various heads, the reader will find a notice of the principal magistrates of all ages and countries.

Magma (Gr. from μάσσω, *I knead*). A thick ointment or confection. The term is also applied to any pulpy or pasty mixtures, or precipitates.

Magna Charta. [CHARTA, MAGNA.]

Magnates (Lat. found only in inscriptions). In Hungary at this day, and formerly also in Poland, the title of the noble estate in the national representation. [STATES.] The Hungarian magnates are divided into greater and lesser; certain high state officers belonging to the first class, the counts and barons of the kingdom to the second.

Magnesia (MgO). A white, tasteless, earthy substance, usually obtained by exposing its hydrated carbonate to a red heat. Its specific gravity is about 3·4. It is almost insoluble: but when moistened and put upon turmeric paper it reddens it: this sometimes depends upon a trace of lime. In commerce, pure magnesia is generally distinguished by the term *calcined magnesia*; and the hydrated carbonate of magnesia, obtained by precipitating a solution of sulphate of magnesia by carbonate of soda and washing and drying the precipitate, goes by the name of *magnesia*, or *magnesia alba*. The chief use of magnesia and its carbonate is in medicine. *Sulphate of magnesia* is obtained by evaporating the residue of sea-water after the common salt has been separated, or by adding sulphuric acid to *bittern*, and evaporating, so as to obtain the resulting sulphate of magnesia. This salt is also obtained by the action of dilute sulphuric acid on magnesian limestone, and it is not uncommon in mineral waters: it was formerly procured from certain springs near Epsom, in Surrey, and was hence termed *Epsom salt*. It crystallises in four-sided prisms with dihedral summits. Its crystals are soluble in their weight of water at 60°, and in three-fourths their weight at 212°. They melt when heated, and gradually lose their water of crystallisation. They consist of 20 magnesia, 40 sulphuric acid, and 63 water. This salt is a useful purgative in medicine, and is the chief source of the other forms of magnesia. All the magnesian salts have a peculiar bitterish taste; hence the German term bittererde, *bitter-earth*. Magnesia is found native in the state of hydrate and carbonate; it exists as a component part of several minerals, and many of them are soft or soapy to the touch. A native hydrate of magnesia occurs in the serpentine rocks at Hoboken, in New Jersey, and also in Unst. one of the Shetland Isles. It has a pale greenish hue and a soft lamellar texture.

Magnesian Limestone. A mixed carbonate of lime and magnesia is sometimes met with in rock masses putting on the appearance of common limestone, but generally harder and heavier. When crystalline, it is called *dolomite*, but the crystallisation is generally imperfect. Magnesian limestone is comparatively slowly soluble in dilute acids, and in this respect is unlike the common limestones. Nevertheless, as a building stone, it appears to be less fitted for London use than many of the ordinary limestones.

Geologically, the magnesian limestones occupy a definite position among the newest palæozoic rocks. This part of the series is known as Permian, the most important features of the rock being developed in the kingdom of Perm in Russia.

Physically, the magnesian limestone is in many parts of England a cliff often steeply scarped, overhanging the coal measures. Parts of it seem to have been a coral deposit built on the edges of coal measures, but these have since been altered chemically perhaps by magnesian vapours. Fossil fish are common in some parts of the series, and a highly bituminous schist containing argentiferous copper (the *Kupfer schiefer* of German geologists) is characteristic of certain deposits at the base of the series developed in Germany.

Magnesite. Native carbonate of magnesia. It forms an immense bed at Bolton in Canada, and also occurs extensively in Greece.

Magnesium. The metallic base of magnesia (represented by the symbol Mg, and the equivalent 12) was discovered by Davy in 1808, who obtained it by electrising mercury in contact with magnesia, and also by passing the vapour of potassium over magnesia at a white heat. In 1830, Bussy obtained it by the decomposition of chloride of magnesium by potassium. It has since been prepared in large quantities, by the action of sodium on chloride of magnesium, and is now manufactured for commercial purposes. Magnesium is a white metal, of the specific gravity of about 1·75: it may be drawn into wire and laminated; it melts and volatilises at about the same temperature as zinc, i.e. at a bright red heat. It is unchanged in dry air, and is only slowly oxidised in damp air; it does not decompose water and liberate hydrogen at common temperatures, but is rapidly acted upon by dilute acids. Heated to redness in the air, it burns with a dazzling bluish white light, rich in the chemical rays, so that its flame has been very successfully applied to the purposes of photography; it readily combines with the halogens, and forms a nitride with nitrogen. Magnesia is its only oxide, which is constituted of 12 of magnesium and 8 of oxygen = 20 magnesia.

Magnet, Natural. One of the native oxides of iron is capable of being magnetically excited, which excitement is retained by it as tenaciously as by steel. Now as the natural blocks of this magnetic substance have lain for ages in nearly the same position with regard to the magnetic meridian, they have acquired magnetic polarity; in other words, they have become natural magnets, and retain this character after removal from the stratum in which they are found. The natural magnet is usually of a dark-grey hue, and has a dull metallic lustre. It is found in considerable masses in the iron mines of Sweden and Norway; in the Isle of Elba; in different parts of Arabia, China, Siam, and the Philippine Islands. Small magnets are also occasionally, though rarely, met with among the iron ores of this country.

The earlier navigators believed that the magnet pointed always to the north pole of the earth; and that therefore by means of it they could always at once tell the direction of their meridian, and consequently in what *direction* they were sailing. It was hence called the *loadstone* or *leading stone*.

The employment of the loadstone itself for the purposes of navigation has long been laid aside; as *artificial magnets* can be constructed having a much greater intensity of directive power. [Magnetism.]

Magnetic Compasses. [Compass.]

Magnetic Compensator. A contrivance devised by Mr. Barlow, but now seldom used, for eliminating the influence of a ship's guns and other iron in deranging the bearings of the compass. It consists of a plate or combination of plates of iron placed near the binnacle, so as to counteract, by an equal and opposite attraction, that of the rest of the iron on board the vessel. Mr. Airy (*Philosophical Transactions* 1839) has investigated the law of disturbance in the case of vessels built of iron, and shown that the disturbing force consists of a very large force of permanent magnetism in the rolled and hardened plates employed in the construction of the vessel, and a very small force of induced magnetism, which changes with the place of the ship, or rather with the varying circumstances of terrestrial magnetism by which it is produced. Mr. Airy has given a set of practical rules for correcting the disturbing forces by means of two powerful magnets placed at right angles to each other below the compass, and a box of small iron chain, which is used instead of Barlow's correcting plate.

Since, however, both the disturbing magnetic elements are liable to gradual or even sudden variation, it is absolutely necessary that the accuracy of the compensation should be frequently tested. The use of iron in ship building and for the plating of vessels of war has rendered a re-investigation of this matter necessary. Recent valuable contributions to our knowledge of the subject will be found in the *Proceedings of the Royal Society*, vol. xiv. pp. 186, 300. [Deviation of the Compass.]

Magnetic Iron-ore. [Magnetite.]

Magnetic Needle. A small bar of hard steel suspended by its centre, and magnetised, which shows the direction of the resultant of the magnetic forces at the place of observation. [Compass; Dipping Needle.]

Magnetic Pyrites. Native sulphide of iron, so called in consequence of its attracting the magnetic needle. It generally occurs massive and amorphous, with a granular structure, but sometimes (though rarely) crystallised.

Magnetic Tube. [Tube.]

Magnetism. The science which investigates the phenomena presented by natural and artificial magnets, and the laws by which they are connected. The following brief explanation of it under both aspects may serve to render the subject generally intelligible; but it is impossible to give more than the essential phenomena and the general laws, without descending to the detail of particular cases. For further information reference may be made to the excellent compendium of Dr. Roget, in the *Library of Useful Knowledge*; to Barlow's *Magnetic Attractions* (2nd ed.), and 'Treatise on Magnetism' in the *Encyclopedia Metropolitana*; Sir D. Brewster's 'Treatise on Magnetism' in the *Ency. Brit.*; Gilbert, *De Magnete*, 1600, folio; Robison's *Mechanical Philosophy*; Biot, *Traité de Physique*, tom. iii.; Pouillet, *Élémens de Physique*; Becquerel, *Traité d'Électricité et du Magnétisme*; Faraday's *Experimental Researches*; Watt's *Dictionary of Chemistry*, art. 'Magnetism;' and various papers in the *Transactions of the Royal Society of London and Edinburgh*.

If a nicely balanced piece of steel be suspended from its middle by a piece of untwisted silk, or allowed to rest upon a pivot, free to turn in all directions, both horizontally and vertically; and if it be then magnetised by any of the methods hereafter described, it will turn itself into one particular position, and if disturbed by any means it will return invariably to the same as its position of repose. The horizontal angle which it makes with the meridian is called its *variation*, or its *declination*; and the vertical angle which it makes with the horizon its *dip* or *inclination*.

On the Formation of Artificial Magnets.—1. If a steel bar be held in the natural direction of the needle, and two or three smart blows be given at the upper end with a hammer, it will become a permanent, though feeble, magnet.

2. If the end of a steel bar be placed in contact with one of the poles of a magnet, it will become permanently magnetic by induction. A better plan is to place the bar in a line between the opposite poles of two magnets of great intensity.

3. Lay the bar flat on a table, and draw a magnet (placed upright upon the centre of it) several times to one end, always the same way. Or take two magnets, and lay them horizontally upon the bar to be impregnated, having their dissimilar ends in contact over its middle; and slide each towards the end of the bar. This must be repeated several times. Or,

again, instead of laying them horizontally, hold them in any angle of inclination (each in the ne angle, estimated from the perpendicular to the middle of the bar), and draw them several times along towards the ends, without varying their inclinations.

The above methods were those originally employed; but when the principles of magnetic induction came to be better understood, more complicated but more effective processes were invented, for the explanation of which reference must be made to works expressly on the subject. (Brewster's *Treatise on Magnetism.*) Those more complicated processes may be greatly simplified by the substitution of a magnet in the form of a horse-shoe for the compound magnets. If placed at once in the middle of the needle to be magnetised, with the poles turned in a direction the reverse of the poles intended to be given to the needle, and then moved backwards and forwards along the surface of the needle, taking care to pass over each half of it an equal number of times, and repeating the same operation on the other side, the needle is speedily and effectually rendered magnetic. This is by far the simplest mode of magnetising; and it may be considered as a method by induction, the induction being accelerated by the friction.

On the principal Phenomena exhibited by Artificial Magnets.—In the following phenomena the point of the needle which dips below the horizon, and points to the westward of the meridian, is called the *north pole* of the needle, and the elevated one the *south pole.* When the horizontal needle is used, the same terms apply; the end which varies westward being the north pole, and the other the south pole.

Phenomenon 1. If either pole of a magnet be brought near any small piece of soft unmagnetised iron, it will be found to attract it. Iron filings, for instance, are immediately collected together when a magnet is placed among them; and they adhere to it when lifted up, and more especially about the poles of the magnet, in thick clusters. About the intermediate parts the number that adhere is much less than nearer the ends; and in every magnet there is a part to which the filings have no tendency to adhere at all. It thus appears that the magnetic forces, whatever be their nature, are concentrated near the extremities of the magnet; and diminish in intensity as they recede from those extremities.

Phenomenon 2. When, instead of fragments of iron, we substitute a rectangular or cylindrical bar of soft unmagnetised iron, the magnet and the iron will be mutually attracted towards each other. The best mode of exhibiting this is to suspend them by threads of untwisted silk at the appropriate distances, as the friction which they would undergo in sliding on a table is thus removed. It will be found that the ends which are nearest to each other will tend to coalesce. If another iron body be brought near the former in this state of the apparatus, the first iron will be found to be converted into a *temporary* magnet also; and, in like manner, the second piece of iron may be proved to have become likewise a temporary magnet; and then the third, and so on. The intensity of attraction and repulsion is, however, weaker in each in succession, till at length it becomes insensible. This is prettily exhibited by attaching a key to a magnet, a nail to the key, a smaller nail to that, a sewing needle to the smaller nail, and so on, as long as there is sufficient induced magnetic force to sustain the series in a state of suspension. The iron is said to be converted into a magnet; or to be *magnetised by induction.*

Phenomenon 3. If two magnets be suspended, as in the last experiment, it will be found that the two north poles repel each other, and the two south poles repel each other; but the north pole of the one and the south pole of the other mutually attract each other. They will, in consequence of this mutual action upon each other, take positions *generally* different from those which they would each take in the absence of each other.

Phenomenon 4. If the poles of the successive induced magnets spoken of in Phenomenon 3 be examined as to their nature, by means of their action on the poles of a small magnetic needle, it will be found that each of them is a distinct magnet, each consecutive pair of th m having their dissimilar poles in contact. This is known at once by observing which end of the needle is attracted before the next piece of iron is put on, and which after it is added, the needle being applied near the untouched end of the iron.

If, moreover, the pieces of iron be laid on a table and not in contact, the same phenomena will be observed on the application of the trial needle near their extremities.

Phenomenon 5. If the iron be removed, it instantly ceases to be magnetic, and may have its position reversed with precisely the same effect as before, each phenomenon taking place now at the end opposite to that where it was exhibited before; and this will be the case, however long the apparatus has been allowed to remain in the position spoken of. If, however, pieces of steel be employed, the inductive influence is less than in the iron whilst, instead of losing its magnetism instantaneously, as the iron did, it retains portion of it, and becomes itself a permanent magnet. There are indeed few, if any, pieces of iron and steel in which the magnetic force is wholly lost or wholly retained upon removal; but we here speak of the sensible and approximate circumstances of the phenomena.

Phenomenon 6. If a magnet be broken or any way severed, it is converted into two separate magnets; the two ends of the fragments at which the fracture was made being of opposite kinds to the two ends of the whole bar respectively, as if they had been but two magnets united by opposite poles.

Phenomenon 7. If two magnets be brought near each other, their intensity of action on the

vibrations of a needle are affected according to the relative positions of the poles, indicating not only that the direction of the quiescent state of the needle is affected (Phenomenon 3), but that the intensity of the magnetic force is also altered. This shows that the magnetised bar itself is affected by the inductive power of the other bar, as soft iron is.

Phenomenon 8. If a mass of soft iron be brought into the vicinity of a magnetic needle, the needle will be *generally* deflected from its natural position in various degrees and directions, according to the form and position of the needle and the mass. When an iron sphere is employed, as a cannon ball, the investigation of the order of the phenomena becomes more simple and easy; and it was by remarking that in this case there was a certain plane in any point of which the needle may be placed with respect to the sphere where the needle would not be at all deflected, that Mr. Barlow was led to prosecute his celebrated experiments on this subject. Mr. Christie remarked that this plane was the plane passing through the centre of the ball, perpendicular to the *natural* direction of the needle itself.

Phenomenon 9. If discs of various metals be put into rapid rotation, they will also deflect the magnetic needle from its natural position. That this is not owing to vibration or vorticity produced in the air, is rendered evident by the same effects taking place in a more intense degree in vacuo than in the open air. The phenomenon itself was first observed by Arago in France; but it has been chiefly investigated in this country by Herschel, Babbage, Christie, Barlow, Faraday, and Harris, to whose memoirs on the subject, in the *Philosophical Transactions*, the reader is especially referred.

Phenomenon 10. Bars which have stood long in a vertical position, as iron railings, &c., are found to have become permanently magnetic. A bar of soft iron, placed in the natural direction of the magnetic needle, acquires temporary magnetism; and if a bar of steel be left there for a sufficient time, it becomes a permanent magnet. These facts show that the earth itself is a great magnet, and converts the others into magnets by induction. This was observed so far back as the time of Dr. Gilbert; and it is remarkable that, whilst his great contemporary Lord Bacon was perceptively urging the new organon in philosophy. Gilbert was actually putting it into the most careful practice. The doctrine of terrestrial induction, as taught by Gilbert, is the doctrine of the present hour, and with scarcely a single improvement in the whole range of the theory.

The foregoing contain the most important phenomena of magnetism which depend upon terrestrial influence merely: those which depend upon electrical influence will be found under the head ELECTRO-MAGNETISM.

Laws of Magnetic Action.—Law 1. The intensity of the attractive force exercised by the north pole of one magnet on the south pole of another, and its repulsive force on the north pole of the second, varies inversely as the square of the distance of those poles; and the like occurs when we consider the action of the south pole of the first magnet on the north and south poles respectively of the other. The same law, precisely, holds with respect to the attraction of a corpuscle of unmagnetised iron.

This is the fundamental law of the science, and may be considered as the source from which the others flow by mathematical reasoning. It has been determined with great care by several philosophers, but especially Michell and Coulomb, by means of the torsion balance and by the method of oscillations, the squares of the times of oscillation being inversely as the attractive forces.

Law 2. When the needle is very short in comparison with the distance and length of the magnet, and has its centre fixed immovably, but is otherwise at liberty to take any directive position, it will so arrange itself that its line of direction will be in the plane drawn through the two poles of the magnet and its own (the needle's) centre of rotation; and if the line of the needle's direction be produced to meet the magnetic line (or line drawn through the poles), it will divide the latter into segments estimated from the poles, which are in the ratios of the cubes of the distances of the poles from the centre of the needle. When the needle is not small in comparison, as above, the law becomes more complicated.

Law 3. If two magnetic needles be made to vibrate, the intensities of their magnetic forces are as the squares of their number of vibrations made in the same time. This is true, whatever be the planes in which they vibrate, so far as the force is effective in that plane; but for a direct comparison of the ratio of the intensities without further computation, the vibrations of both needles must in both cases be made in the *same plane*. The planes most commonly used for vibration are—the horizontal plane; the plane which has been called the magnetic meridian, or that vertical plane which passes through the natural direction of the needle at the place of observation; and the vertical plane at right angles to this.

Law 4. If the needle be allowed to move vertically in a plane making any angle with the magnetic meridian, the dip in that case is equal to the dip in the magnetic meridian multiplied by the cosine of the inclination of the two planes; and if two planes be taken at right angles, in which the dip is observed, the square of the cotangent of the natural dip at that place is equal to the sum of the squares of the cotangents of the observed dips.

Law 5. The intensity of the horizontal force is equal to the intensity of the whole force multiplied by the cosine of the dip. If, therefore, the same needle be used in all the experiments, and observations be made to determine the dip and horizontal intensity at several different places, the relative intensities of the terrestrial magnetic force can be deduced from those ob-

servations, by the three last laws, for each of the places.

The laws according to which magnetic force is influenced by temperature have been investigated chiefly by Coulomb, Kupffer, Barlow, Christie, and Faraday. It appears generally that between the temperature of $-3°$ and $+127°$ of Fahrenheit the intensity of magnets decreases as the temperature increases; and that at temperatures above 100° a part of the power of the magnet is permanently destroyed, whilst at a red heat the magnetism disappears altogether.

Magnetism, Animal. This alleged influence, or agent, was first heard of in Vienna about the year 1776, when a person of the name of Anthony Mesmer published a thesis *On the Influence of the Planets on the Human Body*. About the same time a Jesuit, called Father Hehl, imagined that by the help of a loadstone and certain steel plates rendered magnetic he had cured several diseases; and being struck with the analogy of Mesmer's views to his own, they entered into a kind of partnership as joint practitioners, and attracted considerable notice; so that, although they soon quarrelled, their system of treatment had acquired some notoriety and many powerful advocates. Hehl continued to practise this new and occult science in Germany; and Mesmer, in 1778, went to Paris, and in the course of a short time performed such wonderful cures, real or imaginary, that his apartments were daily thronged with patients of all ranks, and fees and reputation poured in from all quarters. He here, however, associated himself with a M. d'Eslon, a medical man, who, being more skilful in the art of pleasing patients than his master, contrived to gain the ascendency, and so to disgust Mesmer that he was induced to quit Paris for Spa, where, under the pretence of initiating others in the secrets of his trade, he soon raised about 14,000*l*., with which he retired to his native place (Mersburg in Suabia), and left magnetism and the magnetisers to their own resources.

To ascertain how far the pretensions of the animal magnetisers were entitled to any attention or support, the French government appointed a committee of scientific and unprejudiced persons to investigate its merits, among whom were Bailly, Franklin, and Lavoisier; and it is curious that their report, which was translated into English, and published here in 1785, is not more frequently quoted. 'This pretended agent,' say they, 'is not magnetism; for on examining the grand reservoir of the fluid by a needle and electrometer, neither magnetism nor electricity could be detected. We tried it upon ourselves and others without effect; and on blindfolding those who professed great susceptibility of its influence, all its ordinary effects were produced when nothing was done but when they imagined they were magnetised, while none of its effects were produced when they were really magnetised but imagined nothing was done. So also when brought under a magnetised tree; nothing happened if they thought they were at a distance from it, while they immediately went into violent convulsions when they thought they were near the tree, though really not so. The effects, therefore,' say the commissioners, 'are purely imaginary; and although they have wrought some cures, they are not without danger, for the convulsions sometimes spread among the feeble of body and mind, and especially among women. And, finally, there are parts of the operations which may readily be turned to vicious purposes; and, in fact, immoral practices have already actually grown out of them.'

Although the alleged phenomena of animal magnetism or mesmerism have since been repeatedly investigated, yet little of a tangible or satisfactory nature has been clearly established. In such investigations it is difficult to eliminate sources of error arising from the imagination of the patient, and which have doubtless often led observers astray; but, be the alleged phenomena of mesmerism true or fallacious, it is certain that they have no connection whatever with magnetism.

Magnetism, Terrestrial. During the last quarter of a century immense efforts have been made to determine the phenomena and laws of terrestrial magnetism. The impulse given to the study of this department of science is mainly due to Alexander von Humboldt, who, in 1828, formed an association at Berlin for the purpose of verifying an inference which had been drawn from the comparison of corresponding observations made at London and Upsala by Graham and Celsius in the last century, and more recently at Paris and Kazan by Arago and Kupffer, namely that the irregular movements of the needle take place simultaneously at places very distant from each other. At first the operations were on a very limited scale, being confined to hourly observations on some particular days, previously agreed on, at Berlin and Freyberg; but in the following year the plan received an immense extension in consequence of the establishment by the Russian government of magnetical observatories (acting in co-operation with those of Germany) at St. Petersburg, Kazan, Nicolaieff, and Sitka (on the north-west coast of America); that is to say, across the whole continent of Europe and Asia. A second association was soon after formed at Göttingen by Professor Gauss, by which very important improvements were effected both in the instruments used and the methods of observing, which have been since generally adopted. In 1836 the indefatigable Humboldt addressed a letter to the President of the Royal Society, on the best means of perfecting the knowledge of terrestrial magnetism; and, his suggestions being approved by the council of the society, the government was induced, through the representations of that body, to sanction the establishment, in several of the British colonies, of observatories, equipped with appropriate instruments, and superintended by military or naval officers, with

sufficient assistance at their disposal for making continuous *hourly* or *two-hourly* observations of the different magnetic elements. The places selected were Toronto, St. Helena, the Cape of Good Hope, and Hobarton, in Van Diemen's Land; and, as it was considered important to obtain observations in high southern latitudes, the expedition to the Antarctic seas, under the command of Sir James Clarke Ross, was projected and ordered at the same time. The East India Company likewise promised its cooperation by providing for the establishment and maintenance of observatories at Bombay, Madras, Lucknow, Singapore, and Simla; and at home, a magnetical and meteorological department was added to the Royal Observatory at Greenwich. Latterly the British Association Magnetical Observatory at Kew has become the centre of this class of observations, and it has formed the model of other observatories recently established at Coimbra, St. Petersburg, Lisbon, Montreal, the Mauritius, Melbourne, and other places. The observations (made systematically) at the stations first named, according to rules drawn up by a Committee of the Royal Society, were reduced under the superintendence of Colonel (now General) Sabine, at an establishment maintained by the government, at Woolwich. Several volumes of observations have been published, containing a regular series, since 1840, made at Toronto, Hobarton, and St. Helena; and including those made in 1841 and 1842 by the officers of the Antarctic expedition. In addition to these official volumes, General Sabine has also contributed a series of interesting papers to the *Philosophical Transactions* and the *Reports of the British Association*, containing the results deduced from a comparison of the observations at the different places, the latest being in the *Phil. Trans.* for 1864. This important memoir should be read by all interested in this subject.

A magnetical observation is complete when three elements are determined—the *declination* of the magnetic needle, its *inclination*, and the *intensity* of the force. The two latter, however, are not usually observed directly, but in lieu of them the horizontal and vertical components of the intensity are observed, and, from the variations of the two components, the variations of the inclination and of the force itself are computed. The declination and inclination indicate the direction in reference to the horizontal and vertical planes which a freely suspended needle would assume, so that, in fact, the direction of the magnetic force and its intensity are the two elements sought to be determined. The instruments employed are called by the general name of MAGNETOMETERS [which see].

In order to obtain a knowledge of the laws of terrestrial magnetism, it is necessary that the mean values of the three elements, and the variations of those elements, should be determined at a great number of points taken all over the earth's surface. For the purpose of comparison, the points or stations at which the observations have been made are projected on maps, and lines being drawn through those points at which the mean values are the same in respect of each element, a series of curved lines is obtained, which indicate the values of the elements at the intermediate points with more or less accuracy, according to the proximity of the stations at which observations are made. The curves thus traced through the points of equal declination are called *isogonal*; those through the points of equal inclination, *isoclinal*; and those connecting the points of equal force, *isodynamic*.

Declination or *Variation.*—Although the general direction of the horizontal needle is north and south, there are few places at which it points exactly in the direction of the meridian. At London, and over the greater part of Europe, the north end of the needle declines to the west, while in Siberia and some parts of the North American continent it declines to the east.

The changes which take place in the declination are of three kinds—secular, annual, and diurnal. The laws and period of the secular change are very imperfectly known. At London, in 1550, the declination was 11° 17′ E.; about 1660 it was 0°. Soon after that year the needle began to deviate to the west; and the westerly declination continued to increase till 1815, when it seems to have attained its maximum of 24° 27′ 18″, inasmuch as it has gradually decreased since that time. The mean declination deduced from the observations at the Greenwich Observatory in 1865 was 20° 38′.

The annual variation of the declination was first remarked at Paris by Cassini. From a comparison of observations made at Paris from 1784 to 1788, and at London from 1793 to 1805, Arago found a minimum of declination towards the vernal equinox, and a maximum towards the summer solstice. But it may be doubted whether these ancient observations were sufficiently accurate to determine this question, more especially as the result is not confirmed by the recent observations in the colonial observatories. At St. Helena and Toronto no variation of the rate of the secular change in the different seasons is perceptible. At Hobarton the east declination appears to be, on the average, somewhat greater in the summer months than in the winter months, but the differences are extremely small.

Diurnal Variation.—The declination is also subject to a diurnal change, which was first remarked by Graham, at London, in 1722. The remark was confirmed by the observations of Celsius, and by Hiorter in Sweden (1740–1746), and subsequently by those of Wargentin, who found that the needle declined towards the west from the hours of eight or nine before noon till one or two after noon, and then towards the east till eight or nine in the evening. The same observers also remarked that the needle was affected by aurora, or polar light, and that in the presence of this phenomenon the

change in its mean direction was sometimes as much as 5° in the course of a day. In the *Philosophical Transactions* for 1759 there is a paper by Canton, giving the results of observations on the daily variation during 603 days. On 574 of those days the deviations were regular, and nearly the same as those found by Celsius; on the remaining days they were irregular, and on those days there were displays of aurora. Canton ascribed the diurnal change to the effect of the sun's rays in heating the earth, and thereby diminishing the magnetic force; so that in the morning, when the earth is heated on the eastern side of the meridian, the magnetic force on that side is weakened, and the needle consequently declines to the west; and in the afternoon, as the earth becomes heated on the western side of the meridian, the needle begins to move in the opposite direction, and declines to the eastward of its mean place. Similarly Faraday has ascribed the diurnal variation to the heating of the atmosphere, by which the magnetism of its constituent oxygen is diminished. The amount of the diurnal change is different at different places, and at different seasons of the year. At London, for the years 1817–1819, it was found by Colonel Beaufoy to be from 4′ to 5′ in December and January, and above 11′ in June and August. At the Royal Observatory the mean diurnal range for the year 1846 was, in summer, 15′ 14″; in winter, 11′ 53″; and the mean for the whole year, 13′ 34″. At Toronto and Hobarton the diurnal range is also greatest in the summer months and least in the winter months, and the changes take place at nearly the same hours of local time.

Inclination or *Dip*.—The inclination has a general dependence on the latitude, but it varies considerably at different places under the same latitude. A line drawn through all those places where the dipping needle becomes horizontal (usually, though perhaps improperly, called the magnetic equator) appears to intersect the equator of the earth in four points. In the Atlantic Ocean, between Africa and America, it lies wholly to the south of the terrestrial equator, its greatest south latitude being about 25°. According to Hansteen the nodes or points intersective with the equator of the earth are on the meridians 22° E., 187° E., 120° W., and 108° W.; but these determinations must be taken as subject to considerable uncertainty, the observations being by no means accordant. The other isoclinal lines follow, with more or less irregularity, the direction of the magnetic equator until a high latitude is attained. In Boothia Felix, in latitude 70° 5′ 17″ N., and longitude 96° 45′ 48″ W., Sir James Clarke Ross found the dip to be 89° 59′, within a minute of the vertical; and the needle had there altogether lost its directive power. In the southern hemisphere, on board the Erebus, in 1841, Sir J. C. Ross observed an inclination of 88° 36′ in latitude 75° 22′ S., and longitude 161° 48′ E. (Sabine, *Phil. Trans.* 1843.) The places at which the dipping needle becomes exactly vertical, and to which the above most nearly approach, are usually styled the *magnetic poles*; but, as will be seen presently, they not only do not coincide with, but are at a great distance from, the places at which the intensity of the magnetic force is a maximum—a circumstance which it is necessary to keep in mind, as the term *pole* is also frequently applied to the points of greatest force. Like the declination, the dip is subject to secular, annual, and diurnal changes. At London it was observed by Graham, in 1720, to be 74° 42′; and by Captain Kater, in 1830, to be 69° 38′. The mean of the Greenwich observations for 1865 is 68° 0′; whence it appears that the dip at London is diminishing. The annual variation is scarcely perceptible. At Toronto and Hobarton the range of the diurnal variation of the dip is about 1′·25.

Intensity.—The absolute intensity of the magnetic force, like the declination and dip, varies at different places, and probably at different times. It is compared at different stations by observing the number of oscillations made in a given time by a magnetic bar suspended horizontally by a fine wire or silk fibre. From the large table of results given by Hansteen, it appears that if the intensity at the magnetic equator in Peru (where it was supposed by Humboldt to be a minimum) be unity, then the intensity at Naples is 1·275, at Marseilles 1·294, at Madrid 1·394, at Paris 1·348, at London 1·370, at Christiania 1·420, in Baffin's Bay (lat. 76° 45′ N., long. 58° 20′ W.) 1·705. The maximum intensity hitherto observed is 2·052, and the minimum 0·706. Both observations were made at places in the southern hemisphere, the former by Sir James Clarke Ross, in lat. 73° 47′ S., long. 171° 50′ E. (of London), where the dip was observed to be 87° 4′; and the latter by Erman, in lat. 19° 59′ S., and long. 35° 4′ W., off the eastern coast of Brazil, where the dip is 7° 55′: the two extreme intensities are therefore in the ratio of 1 : 2·906. In both hemispheres there are two points, or rather regions, of maximum intensity, which may be regarded as centres of separate magnetic action. The position of the principal or strongest northern maximum intensity was ascertained by Captain Lefroy, in 1842 and 1843, to be in lat. 52° 19′ N., long. 268° E. (Sabine, *Phil. Trans.* 1846); that of the minor maximum was determined in 1828 and 1829 by Hansteen, and Erman, in the Russian expedition, to be in the meridian of 111° 27′ E. The interval between the two meridians is consequently 270° − 111° = 159°, so that they are not directly opposite. Both points appear to have undergone progressive changes from west to east, though not at the same rate. In the southern hemisphere the two centres of maximum force are still nearer each other in respect of geographical longitude, and the intensity is greater than in the northern hemisphere. (Sabine, *Phil. Trans.* 1850.) The isodynamic lines are in general nearly parallel to each other, and also to the

isoclinal lines, though at some particular places the two sets of lines are nearly at right angles. The intensity does not appear to be affected by elevation above the surface.

Simultaneous Perturbations.—In the volume of Hobarton Observations, 1841 to 1848, Colonel (now General) Sabine gives an interesting comparison of the simultaneous affections of the three elements at Hobarton and Toronto, on one of Gauss's term days, April 21, 1842, these two stations being specially selected for comparison as being geographically situated at nearly opposite points of the globe. The result showed that the amount of disturbance on this day was nearly the same at both stations, and that the instants of extreme disturbance are not unfrequently as nearly identical at both as the nature of the observations enables us to determine. The inference is, that many of the perturbations or particular disturbances observed must be regarded as general affections of the whole globe, manifesting themselves at stations the most remote from each other.

Theory.—Mr. Balfour Stewart recently delivered a valuable discourse on this subject at the Royal Institution, from which the following remarks are extracted, as they show at once the mode of investigation now pursued, and the theory now generally accepted. (*Proceedings of the Royal Institution* for 1863.)

'Gauss, who has done so much to further the science of magnetism, showed, by means of a preconcerted system of observation, that magnetic storms affected the needle at Göttingen and at other stations in Europe at precisely the same moment of absolute time; and after the establishment of the colonial observatories, it was found by General Sabine that the needle was affected in Toronto at precisely the moment when it was disturbed at Göttingen. Nor is it too much to say, with our present knowledge, that these remarkable disturbances break out at the same moment over every portion of our globe.

'Having thus shown that these phenomena are cosmical in their character, the next point of interest is their connection with the sun. This has been placed beyond doubt chiefly through the labours of General Sabine, who found at Toronto and elsewhere that magnetic disturbances obey a law of hours. Mr. Broun also showed the same thing from his observation of the needle at Makerstoun, in Scotland. It may be instructive to point out how this proof was deduced from the colonial observations; and to make the matter plain, let us refer to an imaginary case in the familiar science of meteorology. Suppose that while an observer is watching his thermometer there is a sudden influx of cold weather, and that it is wished to estimate the influence of this upon the thermometer on a given day and at a given hour on that day, what must the observer do? He must endeavour to ascertain, by the best possible means, what indication the thermometer would have afforded at that specified day and hour had there been no cold weather. Comparing this with the actual height of the mercury, and deducting the one from the other, he would clearly obtain a measure of the effect of the cold weather upon the thermometer.

'A similar course was pursued by General Sabine in discussing the colonial magnetic observations, with the object of deducing the laws of disturbances. It was first necessary to ascertain by the best possible means what position the magnet would have assumed at any particular day and hour, had there been no disturbance. Calling this the normal value, the next course was to group together, as disturbed, all those positions of the magnet which differed from the normal by more than a certain small quantity. The necessity for this separation will become evident when it is remarked that the disturbed and the regular observations have different hourly turning-points, and obey very different laws. Thus a disentanglement was effected, which was accomplished by the employment of a separating value. The selection of this value is to some extent arbitrary, but it was shown by reference to a diagram that the disturbance law at Kew was virtually the same, whether this were deduced (in the case of the declination) from ninety-five days of principal disturbances or from all disturbed observations which differ from the normal by more than 3′·3. It was also shown from the same diagram that easterly disturbances prevail at Kew during certain hours of the day, and westerly disturbances at certain other hours, thus exhibiting a daily law, and showing that disturbances are therefore connected with our luminary.

'There is, however, a more interesting and mysterious connection than this. Professor Schwabe, of Dessau, has now for nearly forty years been watching the disc of the sun, and recording the groups of spots which have been visible, and he finds that these have a period of maximum nearly every ten years, two of these periods being the years 1848, 1859. Now it was likewise found by General Sabine, that the aggregate value of magnetic disturbances at Toronto attained a maximum in 1848, nor was he slow to remark that this was also Schwabe's period of maximum sun-spots, and it was afterwards found, by observations made at Kew, that 1859 (another of Schwabe's years) was also a year of maximum magnetic disturbance. This fact is eminently suggestive, and brings us at once into the presence of some great cosmical bond, different from gravitation, adding at the same time additional interest as well as mystery to these perplexing phenomena.

'These are the grounds on which we suspect the sun to be the agent which causes magnetic disturbances, but there is also some reason to believe that on one occasion our luminary was caught in the very act. On the 1st of September 1859, two astronomers, Messrs. Carrington and Hodgson, were independently observing the sun's disc, which exhibited at that time a

very large spot, when about a quarter past eleven they noticed a very bright star of light suddenly break out over the spot and move with great velocity across the sun's surface.

'On Mr. Carrington sending afterwards to Kew Observatory, at which place the position of the magnet is recorded continuously by photography, it was found that a magnetic disturbance had broken out at the very moment when this singular appearance had been observed.

'The next point to be noticed is, that magnetic storms are always accompanied by auroræ and by earth currents. With regard to the latter of these phenomena, a single word of explanation may be necessary. Earth currents are currents of electricity which traverse the surface of our globe, a portion of which is caught up by the telegraphic wires, which are often thereby seriously disturbed in their communications. A table was then referred to which showed that auroræ and earth currents have the same ten-yearly period as sun-spots and magnetic disturbances, so that a bond of union exists between those four phenomena.

'The question next arises, What is the nature of this bond? Now, with respect to that which connects sun-spots with magnetic disturbances we can as yet form no conjecture; but we may, perhaps, venture an opinion regarding the nature of that which connects together magnetic disturbances, auroræ, and earth currents. And here we may remark that this latter bond is the more definitely determined of the two, since the three phenomena which it embraces *invariably occur together*.

'In order to exhibit the evidence upon which this hypothesis rests, it is necessary to refer to what is done at the Kew Observatory.

'Reference was then made to a diagram in which the three curved lines photographed from the magnetometer were exhibited for September 1-2, 1859; and it was seen that about four o'clock in the early morning of September 2, the three components of the earth's magnetism at Kew were simultaneously and abruptly disturbed, and were kept at one side of their normal or undisturbed positions for many hours. During this time there were vivid auroræ which extended over the greater part of the globe, and even to as low a latitude as Cuba, and strong earth currents were also observed by Mr. C. V. Walker, on the various telegraphic lines. These currents were found to change their direction every two or three minutes, going alternately from positive to negative, and back again to positive. It is therefore evident that currents varying in this manner could not have been the *cause* of magnetic disturbances in which the needle was kept on one side of its nominal position for many hours. But the curves of magnetic disturbance further exhibit sharp peaks and hollows, or wavelets, superimposed upon the great disturbance wave, and these wavelets change their direction every two or three minutes, in which respect they are comparable with earth currents. May not these wavelets be connected with earth currents and auroræ; and may not this connection be of the following kind? A peak denotes a small but rapid change of the earth's magnetic force in one direction, and a hollow a similar change in the opposite direction Now in a Ruhmkorff's coil we have—1st, a soft iron core, with a current circulating round it; 2nd, an insulator round the current; 3rd, a secondary coil above the insulator, containing perhaps several miles of fine wire. In this arrangement we have a discharge between the terminals of the secondary coil every time contact with the primary current is made, and one of an opposite character every time this contact is broken.

'But the chief use of the primary current is to reverse the magnetism of the iron core; and could we reverse this, or even change it rapidly without a primary current, we should have the same effect, that is to say, we should have a secondary current in one direction, when the magnetism of the core was rapidly increased, and one in an opposite direction, when this was rapidly diminished. . . . The body of our earth may be likened to the soft iron core of a Ruhmkorff's machine, in which one of the small curve-peaks already alluded to denotes a rapid change of magnetism in one direction, and a hollow a change of the opposite character. The lower strata of the atmosphere again resemble the insulator of the Ruhmkorff's machine, and the upper and rarer strata the secondary conductor; again, the crust of the earth being permeated with moisture, becomes a conductor, and may therefore also be likened to the secondary coil. Whenever, therefore, we have a curve-rise, that is to say, a sudden change of the earth's magnetism in one direction, we should have in the upper strata of the atmosphere and in the crust of the earth currents of one kind; and when we have a curve-fall or a sudden change of magnetism in the opposite direction, we should have similar currents of an opposite description.

'It need hardly be remarked, that those currents which take place in the upper strata of the atmosphere will form auroræ, while those in the crust of the earth will constitute earth currents.

'Now, if this be the nature of that connection which subsists between magnetic disturbances, earth currents, and auroræ, may we not extend our enquiries, and ask, If the sun's action is able to create a terrestrial aurora, why may he not also create an aurora in his own atmosphere? It occurred independently to General Sabine, Professor Challis, and Mr. Balfour Stewart, that the red flames visible during a total eclipse may, indeed, be solar auroræ. In support of this hypothesis it may be remarked that, during the late total eclipse in Spain, Mr. de la Rue, by means of the Kew photo-heliograph, proved that these red flames belong to the sun, and that they extended in one case to the distance of 70,000 miles beyond his photosphere. But, considering the gravity of the sun, we are naturally unwilling to suppose that there can be any

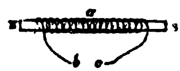
considerable amount of atmosphere at such a distance from his surface; and we are therefore induced to seek for an explanation of these red flames amongst those phenomena which require the smallest possible amount of atmosphere for their manifestation. Now the experiments of Mr. Gassiot and the observed height of the terrestrial aurora alike convince us that this meteor will answer our requirements best. And besides this, the curved appearance of these red flames, and their high actinic power in virtue of which one of them, not visible to the eye, was photographed by Mr. de la Rue, are bonds of union between these and terrestrial auroræ.

'It has been remarked by General Sabine, that an auroral outburst in the sun may perhaps be responded to simultaneously by the different planets. If this be true, our whole solar system would seem to thrill almost like a living being under the excitement of this mysterious force. It has been likewise found by Mr. Gassiot, that electricity cannot pass through a perfect vacuum, so that perhaps we have only to observe the greatest height attained by a terrestrial aurora and by a solar red flame, in order to be able to assign the limit, not only of our own atmosphere, but also of that of our luminary.

'One other point remains to be noticed in connection with magnetic disturbances, and this is, that there appear to be two separate disturbing forces, nearly opposite in character, both connected with the sun, which act simultaneously upon the magnet; the position which the latter assumes being due to the combined effect of both. This has been shown to be true by General Sabine, who has observed that the curve which exhibits the daily range of the east component of the disturbing force, is in many places very different in character from that which exhibits the same for the west component. And this difference between the two curves is of one kind at one station, and of another kind at another station. This duality of the disturbing forces may also be observed directly in the Kew disturbance-curves. . . . The attention of foreign men of science has been much directed to the problem of terrestrial magnetism, and five sets of magnetographs, similar to those in operation at the Kew Observatory, have been already procured by foreign governments. These, however, will be placed in the northern hemisphere, and it is to be desired that some of our colonies in the southern hemisphere may come forward in order that by the next epoch of maximum disturbance (1869) there may be such a network of magnetic observatories as may enable us to obtain the solution of this interesting and important problem.'

Magnetite. Magnetic Iron-ore, or Oxydulated Iron. One of the richest and most important of the ores of iron, and that from which the finest kinds of steel are made. It is a widely diffused mineral, and is found abundantly in many localities, especially in Lapland, Norway, Sweden, and Canada, occurring crystallised in iron-black octahedrons and dodecahedrons, also massive and in the form of sand.

Magneto-electricity. Under the term ELECTRO-MAGNETISM will be found the description of certain magnetic phenomena produced by electricity. It has been demonstrated by Faraday that electric phenomena may be produced by magnetism, and to these the term *magneto-electricity* has been applied. Let *a* represent a hollow helix of copper wire covered by silk, the ends *b c* of which are connected with a delicate galvanometer; and N S a powerful bar magnet, which can easily be thrust into and withdrawn from the spiral or helix: it will then be found that every time the magnet is pushed into the helix the galvanometer is deflected in one direction, and each time it is withdrawn it is deflected in the opposite direction. On repeatedly threading the helix with the magnet, the deflection also takes place. Now, as the deflection of the galvanometer can only be produced by the motion of electricity in the helix, it is obvious that an electric current is produced each time that the magnet moves through it; hence as, on the one hand, electricity in motion produces magnetism, so, here, magnetism in motion produces electricity. By causing the pole of a powerful magnet to revolve before a coil of wire, or, what amounts to the same thing, if the coil be made to revolve opposite to the pole of a magnet, an electric current will be established in the coil, which may be made sensible by sparks, shocks, and chemical effects; and by employing a combination of such magnets and coils a current sufficiently powerful for the electric light may be obtained. In magneto-electricity the source of power is the mechanical force used to rotate the magnet or coil. This force may be supplied by muscular action, as in Wheatstone's magneto-electric telegraph instruments; or it may be derived from the steam engine, as in Holmes's magneto-electric light.



Magnetometer. An instrument for measuring the intensity of terrestrial magnetism. The three elements sought to be deduced from magnetic observations are, the declination, the inclination or dip, and the absolute intensity, together with the variations to which they are subject; and each of these elements requires for its determination a peculiar apparatus. When adapted to the purpose of determining the declination, the magnetometer is called a *declination magnetometer*; when for the horizontal and vertical force, they become *horizontal* and *vertical force magnetometers*. From the experience obtained in the British colonial observatories, it appears that these instruments, at least in the form recommended in the *Instructions* drawn up by the Committee of the Royal Society, are liable to certain sources of irregularity; one depending on the liability of the magnetised bar to lose a portion of its magnetism, and others on causes not perfectly understood. (Sabine, *Phil. Trans.* 1850.) At Green-

wich, Kew, and other important magnetical observatories, the magnetometers are self-recording, a mirror attached to them reflecting a beam of light on to photographic paper kept in motion by proper apparatus. For particulars of the construction of these instruments, see Becquerel, *Traité de l'Électricité et du Magnetisme*, vol. vii., and Daguin, *Traité de Physique*, iii. 78.

Magnetomotor. A term applied to a voltaic series of two or more large plates, which, producing a great quantity of electricity of low tension, is well adapted to the exhibition of electro-magnetic phenomena.

Magnifying Power. As the *illuminating power* of a telescope or microscope depends upon the aperture of the object-glass, so does the *magnifying power* depend upon the focal length and the *depth* or power of the eye-piece. In the telescope this power is generally limited by the illuminating power, as each increase in the size of the image spreads the light over a larger area, until the image is too dim to be observed. In the microscope, as the light can be increased to almost any extent, the magnifying power is proportioned only to the perfection of the object-glass.

Magnitude (Lat. magnitudo). Size, extent, quantity. This term was originally employed to designate the space occupied by any figure; or, in other words, it was applied to objects strictly termed geometrical, and of three dimensions—length, breadth, and thickness: then it was extended to designate the quantity of any one of these, and also of angular space, or the inclination of two lines to one another; or, again, the compound idea of a solid angle formed by any number of planes meeting in a point. The amount of any one of these, taken in reference to some standard of the same kind of quantity as that spoken of, was called its magnitude. The term was gradually enlarged in its signification, so as to apply to every kind of quantity that admits of exhibition or mensuration, or of which greater or less can be predicated; and in this sense it was used by Euclid.

Magnitude, Apparent. The angular space (plane or solid) under which a body appears when viewed from some distant point. The term is chiefly used in speaking of the celestial bodies, and is then employed to express the plane angle subtended by the diameter of the visual disc of the body. It is also used in many branches of optical science; but always with the same *general* meaning.

Magnolia (after Pierre Magnol, professor of medicine at Montpelier). A fine genus of trees or shrubs, some of them evergreen, found in North America, Northern India, and China. Many of them are cultivated for their beautiful tulip-like flowers, often of large size, and deliciously fragrant. One evergreen species, *M. grandiflora*, adds to shining laurel-like leaves large white aromatic flowers of great beauty. *M. glauca* is called in America the Swamp Sassafras, and has qualities resembling those of the true Sassafras.

Magnoliaceæ (Magnolia, one of the genera). A natural order of Exogenous plants of the Ranal alliance, consisting of trees or shrubs of great beauty, usually with evergreen leaves, and large fragrant flowers. They inhabit the temperate parts of America and Asia, as well as the tropics, and are universal objects of cultivation. The bark of the Tulip-tree, *Liriodendron Tulipifera*, and of some of the true Magnolias, has the reputation of being a good febrifuge. *Drimys Winteri* yields Winter's Bark.

Magpie. A common species of the Crow tribe, *Corvus Pica* of Linnæus; now the type of a distinct genus, *Pica caudata*. They continue in pairs throughout the year, and prey on a variety of food, chiefly animal, as the young of hares, rabbits, and feathered game, young poultry, eggs, carrion, and insects; lastly, fruit and grain.

Maguey. The American Aloe, *Agave americana*.

Mahâbhârata. The name of one of the great Indian epic poems, the chief subject of which is a long civil war between two dynasties of ancient India, the Kurus and Pandus. This poem, which embraces the whole circle of Indian mythology, has been recast by later editors, evidently Brahmans, who have in great part changed its epic into a didactic character. This collection of poems is more recent than the Veda, for the war, which is its principal subject, is not known in the latter. (Max Müller, *History of Sanscrit Literature*, pp. 42–48 &c.) Many episodes from the *Mahâbhârata* have been ably translated by some of our most celebrated Orientalists; and parts of the original have been published at different periods in Germany. [Ramayana.]

Mahadeva. In the Mythology of the Hindus, the name of a deity who shares the attributes of Siva in the later Indian Trimurtti, or Trinity. These attributes vary greatly, Mahadeva being regarded as a generator as well as a destroyer. In the earlier Vedic writings Mahadeva, like Rudra, is the name of a god who is described under characters as various as those which are assumed by Heracles and Phœbus in Hellenic Mythology. (Muir, *Sanscrit Texts*, part iv. ch. iii. sect. 7.)

Maharanga (its Nepalese name). A genus of *Boraginaceæ*, of which a Nepal species, *M. Emodi*, yields thick fleshy deep purple roots, which impart a brilliant red to oils. They are the Rutton roots of the Indian bazaars, and oil coloured by them is used for staining wood of a mahogany colour.

Mahogany. The timber of the tree known as *Swietenia Mahagoni*. This is the true or Spanish mahogany. Indian mahogany comes from *Cedrela Toona*; and African from *Khaya senegalensis*.

Mahometanism. [Mohammedanism.]

Maia. In Greek Mythology—1. A daughter of Atlas and Pleione, and mother of Hermes. 2. A Roman divinity, also called Majesta.

Maid of Honour. An attendant of high rank on the person of the queen. [Household.]

A family of crabs (Brachyurous Crustaceans), of which the genus *Maia* is the type. The form of the shell is ovoid; the manus and the preceding joint are nearly of the same length. The species called *Maia Squinado* is occasionally taken on our own coasts, as well as on those of France and of the Mediterranean. It is commonly called the *sea spider*.

Maiden. The name given in Scotland to a sharp-edged instrument, formerly used for the beheading of criminals. It resembles in its construction the *guillotine* of the French. [GUILLOTINE.]

Maidenhair Fern. The *Adiantum Capillus Veneris*; a fern found in many parts of Europe on damp shaded rocks. It formed an ingredient in the syrup of capillaire of old pharmacy. The article now sold under that name is simple syrup flavoured by orange-flower water.

Mail (Fr. maille). A small piece of metal or money; but the word is applied collectively to defensive armour formed of iron rings or round meshes. [HAUBERK.]

MAIL (Fr. malle). A word which signified originally the bag containing letters forwarded by government for the public convenience; but it was soon afterwards extended to the letters themselves, and it is now used also for the conveyance in which they are forwarded. [POST OFFICE.]

Mails or **Maills.** In Scottish Law, the rents of an estate. (Silver halfpence, in England, were anciently called *mailes*.) In the northern counties of England, and in Scotland, payments made by the occupiers or owners of lands to persons in league with the various classes of freebooters who infested the country were termed *black mail*. To take it was made a capital felony by stat. 43 Eliz. c. 13.

Maim or **Mayhem.** In old English Jurisprudence, a wound by which anyone was so disabled as to be less fit to defend himself in fight; and therefore distinguished from an injury which merely disfigured. Appeal of mayhem was abolished, with other criminal appeals, by 59 Geo. III. c. 46.

Main. In a vessel with three masts, the centre mast, hatchway, &c. If she have but two masts, it is the aftermost; unless the vessel be a yawl or ketch, when the mast nearest the bow is the mainmast. In one-masted vessels, if the mast be given a name, it is the mainmast. In all rigs the mainmast is the principal and tallest mast.

Main Beam. In Machinery, the term *main beam* is applied to the beam set in vibration by the piston rod at the one end and connected with the main connecting rod at the other. It has an alternative circular motion about a fixed axle, and serves to transmit to all the machinery the force which it receives at its end. It is generally executed in cast iron, but of late years wrought iron has been frequently employed in this part of machinery. The old steam engines had main beams of wood, which is still largely employed for that purpose in the United States. The connecting rod of the pumps to feed the boiler and to work the air pumps are usually attached to the main beam.

Main Centre. In side lever engines, the shaft upon which the side beams vibrate is called the *main centre*; the shaft on which the beam of a vertical engine describes its motion is also so called.

Main Connecting Rod. The connection between the end of the balance or main beam of an engine and the shaft from which the motion is communicated to the machinery that forms part of the assemblage. It is usually formed of cast or wrought iron, or in old engines it is even executed in wood. At one end it is keyed on to the balance beam, and at the other to a crank immediately connected with the first motion shaft.

Main Link. The term used in Machinery to express the link or the bar connecting the head of the piston with the parallel motion of the balance beam of a steam engine.

Main Pedestal. In Steam Engines, the main pedestals are the parts which are introduced upon the top of the framing for the purpose of bearing the main centres of the balance beam; the points of support of the wheels of a marine steam engine are also so called. They are of cast iron, usually planed and carefully fixed on the framing, and have a brass or gun-metal bush to diminish the friction.

Mainspring of a Watch. [HOROLOGY.]

Maintenance (Fr. maintenir, from Lat. manu tenere, *to hold by the hand*). In Law, an officious intermeddling in a suit that in no way belongs to one, by maintaining and assisting either party with money, or otherwise to prosecute or defend it. The punishment by common law is fine and imprisonment, and by 32 Hen. VIII. c. 9 a forfeiture of ten pounds.

Maintenance, Cap of. A cap of dignity, anciently belonging to the rank of a duke; termed by the French *bonnet ducal*. The lord mayor's fur cap is also called a cap of maintenance.

Maize (mais, the American name). A kind of corn, commonly called Indian corn, consisting of the grain of the plant named by Linnæus *Zea Mays*, which is extensively cultivated for food. Like other corn, it is a species of grass, whose albumen is sufficiently large and farinaceous to be ground into flour. In the Maize the grains are unusually large, compressed, and packed closely in regular parallel lines along the sides of a receptacle many inches long. In the young state each grain is tipped with a long slender style as fine as a thread of silk; and many hundreds of such styles being collected together from each receptacle, the whole resemble a silken tassel hanging down from the orifice of the sheathing leaves in which the inflorescence is enwrapped. When ripe the corn is still covered by the sheathing leaves, and is only to be discovered when the latter are stripped back. The male or

barren flowers grow in a loose panicle at the top of the stem. There are many varieties of maize; some with stems seven or eight feet high, others not exceeding the stature of two feet; some requiring a long summer to ripen their grain, others coming to perfection in a couple of months. The colour of the grain is also variable—chocolate-coloured, red, crimson, yellow, white, and variegated, are all known to the American planter. This kind of corn is not grown exclusively for the sake of the ripe grain; the young female inflorescence, which is sweet and tender, is boiled or cooked in other ways as a delicate vegetable, and the young stems are occasionally given to cattle. Many attempts have been made to cultivate maize in England as a field crop, but without success. It does not thrive north of the basin of the Mediterranean, and requires a higher summer heat than we usually experience in these islands.

Maizena. A fine flour prepared from maize or Indian corn.

Majesty (Lat. majestas). This title of honour is derived from the Romans, among whom it stood for the collective power and dignity of the sovereign body; as majestas populi Romani. Hence treason was termed *crimen læsæ majestatis*, an injury offered to majesty. Majesty was the attribute of consuls, prætors, &c., only as representing the public; and hence, in later times, when it was transferred to the emperors along with the sovereign power, inferior magistrates were entitled, in ceremonial language, by the appellation of *dignitas*. Majesty is now the conventional title of European emperors and kings. (The sultan of Turkey has no more elevated title in our ceremonial than *highness*.) It appears to have been first assumed by the emperors, who represented the imperial dignity of Rome; then by the French king Henry II.; in England by Elizabeth. The emperor of Austria has the title *majesty*, with the prefix K.K. (Kaiserliche, Königliche; i.e. Imperial, Royal).

Apostolical Majesty.—A title bestowed on Stephen, duke of Hungary, about A.D. 1000, by Pope Sylvester II. Reconferred on the empress-queen Maria Theresa in 1758.

Catholic Majesty. — A title bestowed on Ferdinand and Isabella of Spain by Pope Alexander VI. in 1491, in memory of the conquest of the Moors. It had, however, been borne by earlier Spanish monarchs.

Most Christian Majesty.—A title borne by the kings of France; first solemnly conferred on Louis XI. in 1469 by Pope Paul II.

Most Faithful Majesty.—The title of the kings of Portugal; bestowed by Benedict XIV. on John V.

Majolica Ware. A peculiar kind of pottery originally made in the island of Majorca during the occupation of the Mediterranean islands by the Moors. It consisted of a body formed of common earthenware, which was heightened with colour, and received usually a lead glaze. Mr. Minton has lately revived the taste for a ware very similar to that of Majorca; his productions are, however, of much purer taste than the models which he followed.

Major (Lat. *greater*). In the Army, a field officer next in rank above captain, and immediately inferior to a lieutenant-colonel. His chief duties consist in superintending the exercises of his regiment or battalion, and of putting in execution the commands of his superior officer. This class of field officers did not exist till the beginning of the seventeenth century. The prices of a major's commission in the British army are as follow: In the cavalry and infantry of the line, 3,200*l.*; in the life and royal horse guards, with the rank of lieut.-colonel, 5,350*l.* The daily pay is, in the life and horse guards, 1*l.* 4*s.* 5*d.*; in the foot guards, 1*l.* 3*s.*; cavalry, 19*s.* 3*d.*; infantry, 16*s.* The regimental rank of major does not exist either in the artillery, engineers, or marines. The major of brigade is a staff officer, who performs for a brigade, or in a garrison, duties equivalent to those of an officer of the adjutant-general's department. *Major-general* is an officer next in rank below a lieutenant-general.

Major Domo (Lat. major domus, *greater officer of the house*). In the courts of those kingdoms which were formed out of the fragments of the Western Empire, three different offices seem to be designated by this title: 1. The maître d'hotel, or chief officer of the prince's table, præfectus mensæ, architriclinus, dapifer, &c.; 2. The mayor of the palace (œconomus, *steward*); 3. The first minister, prefect of the palace, count of the palace, &c. Charles Martel is termed major domus by some ancient historians. This title became in later times confounded with that of seneschal. In Germany, under the Othos and the house of Swabia, the dapifer was an officer of high rank, who bore, amongst other duties, the standard of his sovereign. The count palatine was dapifer of the empire: the elector of Bavaria, arch-dapifer. In England he was a personage of less distinction, and his subscription generally appears last among the attesting witnesses to ancient charters.

Major and Minor. In Music, terms applied to imperfect concords differing from each other by a semitone minor. For Major and Minor Keys, see KEY.

Major Term. In Logic, in a syllogism, the predicate of the conclusion. The major premiss is that which contains the major term. In hypothetical syllogisms, the hypothetical premiss is called the major.

Majorat (Fr.). In modern legal phraseology, as employed by several Continental nations, the right of succession to property according to age. It is defined 'a fidei commissum gradual, successive, perpetual, indivisible, made with a view to preserve the name, arms, and dignity of a family, and destined for ever to the eldest member of it.' In the German empire and in Spain this species of entails is of great antiquity. [MAYORAZGO.]

The German and Spanish laws of majorat had no exact equivalent in old France; but

a species of majorat existed in the case of the Duchés-Pairies, abolished at the Revolution, with other feudal institutions. The general rule of French law, that children succeed equally to their parents' property, is only modified by the regulations respecting what is termed a *portion disponible*. (*Cod. Civil*, art. 913 &c.) A person who leaves one child only can dispose, by will or donation, of half his property; one who leaves two one-third; and so on; a person who dies without descendants, but leaving 'ascendants,' one-half or three-fourths, according to certain rules; if he leaves only collaterals, he may dispose of the whole. The term *majorat* is still used in France to express the property, landed or funded, which by virtue of several decrees of the first empire might be reserved by persons enjoying hereditary titles of honour, and attached to the title so as to descend with it.

Majority. In Politics, the age at which the sovereign, in hereditary monarchies, becomes capable of exercising supreme authority. [MINORITY; REGENT.]

Majusculæ or **Capitales Literæ.** In Diplomatics, capital letters. The Latin manuscripts of the classical age which we possess (those found at Pompeii, and a few parchment MSS. of very early date) are written in capital letters. Few instruments or books of a later date than the sixth century are in capital letters.

Mal de la Rosa (Span. *rose-evil*). A disease endemic in the Asturias, attended by redness of the skin.

Malabathrum (Lat.; Gr. μαλάβαθρον). The leaf of the Cassia laurel, from Malabar, *Cinnamomum malabathrum*.

Malachite (Gr. μαλακός, *soft*; hence also sometimes called *Velvet* Copper-ore). Malachite — Green Carbonate of Copper is a *copper-stalactite* or *stalagmite* containing about 57·33 per cent. of the metal. It is common in Cornwall, and is a frequent constituent in the copper ores of South Australia, Siberia, and other countries. It seldom occurs crystallised, but generally in masses with botryoidal or reniform surfaces, and banded internally with various shades of bright green. It is in great request for ornamental purposes on account of the beauty of its colour, the variety of its markings, and the high degree of polish which it may be made to receive.

Malacia (Gr. μαλακία, *weakliness*). A depraved appetite.

Malacoderms (Gr. μαλακός, and δέρμα, *skin*). The name of a tribe of Serricorn beetles, including those with a soft and flexible body.

Malacolite (Gr. μαλακός, and λίθος, *stone*). A variety of Augite of a dark-green colour. [SAHLITE.]

Malacology (Gr. μαλάκια, the Aristotelian name of the Mollusca of the moderns). The science of the MOLLUSCS [see that word for their general characters]. Cuvier, the great reviver of this branch of natural history, divided the Molluscs into six classes:—

I. *Cephalopoda*.—Mantle in form of a sac, open anteriorly, containing the branchiæ and abdominal viscera; head protruding from the mantle, well developed, and crowned by fleshy productions, by means of which they crawl and seize various objects.

II. *Pteropoda*.—Mantle closed; appendages of the head either wanting or extremely reduced. The principal organs of locomotion are two membranous fins, like wings, situated on the sides of the neck.

III. *Gastropoda*.—These crawl by means of a fleshy disc on their belly. The mouth is supported by a head.

IV. *Acephala*.—The mantle encloses the branchiæ and viscera; the mouth opens within its cavity, and is not supported by a distinct head. The mantle may be open throughout its length, at both ends, or at one extremity only.

V. *Brachiopoda*.—These are also enclosed in a mantle without an apparent head; but have a pair of long, fleshy, ciliated arms, which are spiral when retracted.

VI. *Cirrhopoda*.—This class Cuvier defines as being similar to the other Molluscs in the mantle, branchiæ, &c.; but as differing from them in having numerous horny and articulated limbs, and a nervous system more nearly resembling that of the Articulata.

Since the early form and metamorphoses of the *Cirrhopoda*, or, more properly, *Cirripedia*, were known, most zoologists have regarded them as members of the Articulate sub-kingdom.

The classification of the Mollusca has been much perfected by those zoologists who have been attracted to the study of this department of the animal kingdom by the beautiful and diversified coverings of the testaceous species. Among these Lamarck ranks deservedly the chief; and his system has long guided the conchologist in the arrangement of his shells.

In the system of Lamarck, the natural primary group of animals to which the science of malacology relates constitutes the 11th and 12th classes of his Invertebrata. The first of these classes, under the name of *Conchifera*, is equivalent to the Testaceous *Acephala* and *Brachiopoda* of Cuvier; and these low-organised headless Mollusca have their external shelly defensive covering rendered the more complete by way of compensation for the slight developement of the nervous centres to which the impressions of external objects are referred, and from which the acts of volition emanate. Instead of one shell, they are therefore provided with and generally completely covered by two shells, which are technically called *valves*; and the *Conchifera* of Lamarck thus include the Molluscs with bivalve shells. These are divided into two orders, *Dimyaria* and *Monomyaria*.

The following classification, by the late Dr. Woodward, is now generally adopted, and

has entirely superseded the Lamarckian system:—

CEPHALOPODA.

DIBRANCHIATA.

Argonautidæ.—Argonauta, *Linnæus.*

Teuthidæ.—Loligo, *Lamarck.* Sepioteuthis, *Blainville.* Beloteuthis, *Münster* (Teudopsis, *Deslongchamps*). Geoteuthis, *Münster.* Leptoteuthis, *Meyer.* Cranchia, *Leach*, 1817. Sepiola, *Leach*, 1817 (Rossia, *Owen*). Loligopsis, *Lamarck*, 1811. Cheiroteuthis, *D'Orbigny.* Histioteuthis, *D'Orbigny.* Onychoteuthis, *Lichtenstein.* Enoploteuthis, *D'Orbigny.* Ommastrephes, *D'Orbigny.*

Belemnitidæ.—Belemnites, *Lamarck*, 1801. Belemnitella, *D'Orbigny.* Acanthoteuthis, *Münster.* Conoteuthis, *D'Orbigny.*

Sepiadæ.—Sepia, *Linnæus* (Coccoteuthis, *Owen*). Spirulirostra, *D'Orbigny.* Beloptera, *Deshayes.* Belemnosis, *Edwards.* Helicerus, *Dana.*

Spirulidæ.—Spirula, *Lamarck.*

TETRABRANCHIATA.

Nautilidæ.—Nautilus, *Breynius*, 1732 (Aturia, *Bronn.* Discites, *M'Coy.* Trigonoceras, *M'Coy.* Temnocheilus, *M'Coy.* Cryptoceras, *D'Orbigny*). Lituites, *Breynius.* Trochoceras, *Barrande*, 1848. Clymenia, *Münster*, 1832.

Orthoceratidæ.—Orthoceras, *Breynius* (Cameroceras, *Conrad.* Endoceras, *Hall.* Tretoceras, *Salter.* Huronia, *Stokes*). Actinoceras, *Stokes* (Hormoceras, *Stokes.* Discosorus, *Hall.* Apioceras, *Fischer*). Gomphoceras, *J. Sowerby*, 1839. Phragmoceras, *Broderip.* Cyrtoceras, *Goldfuss*, 1833. Gyroceras, *D'Orbigny.* Ascoceras, *Barrande*, 1848.

Ammonitidæ.—Goniatites, *De Haan.* Ceratites, *De Haan.* Ammonites, *Bruguière.* Crioceras, *Leveillé.* Toxoceras, *D'Orbigny.* Ancyloceras, *D'Orbigny.* Scaphites, *Parkinson.* Helicoceras, *D'Orbigny.* Turrilites, *Lamarck.* Hamites, *Parkinson.* Ptychoceras, *D'Orbigny.* Baculites, *Lamarck.*

GASTEROPODA.

PECTINIBRANCHIATA, *Cuvier.*

(*Siphonostomata.*)

Strombidæ.—Strombus, *Linnæus.* Pteroceras, *Lamarck.* Rostellaria, *Lamarck* (Spinigera, *D'Orbigny*, 1847). Seraphs, *Montfort.*

Muricidæ.—Murex, *Linnæus* (Typhis, *Montfort.* Trophon, *Montfort*). Pisania, *Bivon*, 1832. Columbella, *Lamarck.* Columbellina, *D'Orbigny.* Fasciolaria, *Lamarck.* Mitra, *Lamarck* (Imbricaria, *Schumacher.* Cylindra, *Schumacher.* Hyalina, *Schumacher*). Turbinella, *Lamarck* (Cynodonta, *Schumacher.* Latirus, *Montfort.* Lagena, *Schumacher*). Fusus, *Lamarck* (Clavella, *Swainson.* Fulgur, *Montfort.* Myristica, *Swainson.* Pusionella, *Gray.* Chrysodomus, *Swainson*).

Buccinidæ.—Buccinum, *Linnæus.* Pseudoliva, *Swainson.* Anolax, *Conrad.* Halia, *Risso.* Eburna, *Lamarck.* Nassa, *Lamarck* (Cyllene, *Gray.* Northia, *Gray.* Cyclonassa, *Swainson*). Phos, *Montfort.* Purpura, *Lamarck* (Concholepas, *Favan.* Cuma, *Humphrey.* Rapana, *Schumacher*). Monoceras, *Lamarck.* Purpurina, *D'Orbigny.* Amberlya, *Morris and Lycett.* Ricinula, *Lamarck.* Magilus, *Montfort* (Leptoconchus, *Rüppel*). Harpa, *Lamarck.* Oliva, *Lamarck* (Olivella, *Swainson.* Scaphula, *Swainson.* Agaronia, *Gray*). Ancillaria, *Lamarck.*

Cassididæ.—Cassis, *Lamarck.* Oniscia, *Sowerby.* Dolium, *Lamarck* (Malea, *Valenciennes*). Cassidaria, *Lamarck.* Triton, *Lamarck.* Nassaria, *Pfeiffer.* Ranella, *Lamarck.* Pyrula, *Lamarck.*

Conidæ.—Conus, *Linnæus* (Conorbis, *Swainson*). Pleurotoma, *Lamarck* (Drillia, *Gray.* Clavatula, *Lamarck.* Cithara, *Schumacher.* Tomella, *Swainson.* Borsonia, *Bellardi.* Clionella, *Gray.* Mangelia, *Leach.* Bela, *Leach.* Defrancia, *Millet.* Daphnella, *Hinds*). Lachesis, *Risso.* Terebra, *Lamarck.*

Volutidæ.—Voluta, *Linnæus* (Volutilithes, *Swainson.* Scaphella, *Swainson.* Volutomitra, *Gray.* Melo, *Broderip*). Cymba, *Broderip.* Marginella, *Lamarck.*

Cypræidæ.—Cypræa, *Linnæus* (Cyprovula, *Gray.* Luponia, *Gray.* Trivia, *Gray*). ? Pachybathron, *Gaskoin.* Erato, *Risso.* Ovulum, *Lamarck* (Volva, *Fleming.* Radius, Montfort).

HOLOSTOMATA.

Naticidæ.—Natica, *Lamarck* (Naticopsis, *M'Coy.* Euspira, *Agassiz.* Neverita, *Risso.* Lunatia, *Gray.* Globulus, *J. Sowerby.* Deshayesia, *Raulin.* Polinices, *Montfort.* Cernina, *Gray*). Sigaretus, *Lamarck* (Naticina, *Gray*). Lamellaria, *Montagu* (Oncidiopsis, *Beck.* Marsenina, *Lovén*). Velutina, *Fleming.*

Cancellariadæ.—Cancellaria, *Lamarck* (Admete, *Philippi*). Trichotropis, *Broderip.* ? Cerithiopsis, *Forbes and Hanley.* ? Separatista, *Gray.*

Pyramidellidæ.—Pyramidella, *Lamarck.* Odostomia, *Fleming.* Aclis, *Lovén.* Chemnitzia, *D'Orbigny.* Loxonema, *Phillips.* Macrocheilus, *Phillips.* Eulimella, *Forbes.* Monoptigma, *Lea.* ? Chilostoma, *Deshayes.* Eulima, *Risso* (Niso, *Risso*). Stylina, *Fleming.*

Solariadæ.—Solarium, *Lamarck* (Philippia, *Gray.* Torinia, *Gray.* Bifrontia, *Deshayes*). Discohelix, *Dunker.* Platystoma, *Hörnes.*

Scalariadæ.—Scalaria, *Lamarck.*

Cerithiadæ.—Cerithium, *Bruguière* (Rhinoclavis, *Swainson.* Bittium, *Leach*). ? Ceritella, *Morris and Lycett.* ? Brachytrema, *Morris and Lycett.* Triforis, *Deshayes.* Potamides, *Brongniart* (Vicarya, *D'Archiac.* Cerithidea, *Swainson.* Terebralia, *Swainson.* Pyrazus, *Montfort.* Lampania, *Gray*). Diastoma, *Deshayes.* Fastigiella, *Reeve.* Planaxis, *Lamarck* (Quoyia, *Deshayes*). Nerinæa, *Defrance.* Aporrhais, *Aldrovandus.* Alaria, *Morris and Lycett.* Struthiolaria, *Lamarck.*

Turritellidæ.—Turritella, *Lamarck.* Proto, *Defrance.* Holopella, *M'Coy.* Mesalia, *Gray.* ? Scoliostoma, *Braun.* Cæcum, *Fleming.* Vermetus, *Adanson* (Petaloconchus, *Lea.* Serpulorbis, *Sassi*). Siliquaria, *Bruguière.*

Melaniadæ.—Melania, *Lamarck* (Melanatria, *Bowdich*. Vibex, *Oken*. Ceriphasia, *Swainson*. Hemisinus, *Swainson*. Melafusus, *Swainson*. Melatoma, *Anthony*. Anculotus, *Say*. Amnicola, *Gould and Huxley*). Paludomus, *Swainson*. Tanalia, *Gray*. Melanopsis, *Lamarck*. Pirena, *Lamarck*.

Paludinidæ.—Paludina, *Lamarck*. Bithinia, *Gray*. Valvata, *Müller*. Ampullaria, *Lamarck* (Pomus, *Humphrey*. Marisa, *Gray*. Asolene, *D'Orbigny*). Lanistes, *Montfort*. Meladomus, *Swainson*. ? Amphibola, Schumacher.

Litorinidæ.—Litorina, *Férussac* (Tectaria, *Cuvier*. Modulus, *Gray*. Risella, *Gray*). Narica, *Recluz* (Naticella, *Münster*). Fossarus, *Philippi*. Lacuna, *Turton*. Litiopa, *Rang*. ? Cheletropis, *Forbes*. ? Macgillivrayia, *Forbes*. Rissoa, *Frémenville* (Rissoina, *D'Orbigny*). ? Jeffreysia, *Alder* (Skenea, *Fleming*. Hydrobia, *Hartmann*). Paludestrina, *D'Orbigny*. Lithoglyphus, *Muhlfeldt*. Nematura, *Benson*. Syncera, *Gray*. Truncatella, *Risso*.

Calyptræidæ.—Calyptræa, *Lamarck* (Crucibulum, *Schumacher*. Trochita, *Schumacher*). Crepidula, *Lamarck*. Pileopsis, *Lamarck* (Amathina, *Gray*). Metoptoma, *Phillips*. Platyceras, *Conrad*. Hipponyx, *Defrance* (Amalthea, *Schumacher*). ? Phorus, *Montfort*.

Turbinidæ.—Turbo, *Linnæus*. Phasianella, *Lamarck*. Imperator, *Montfort*. Trochus, *Linnæus* (Pyramis, *Chemnitz*. Gibbula, *Leach*. Margarita, *Leach*). Elenchus, *Humphrey* (Bankivia, *Muhlfeldt*). Rotella, *Lamarck*. Monodonta, *Lamarck*. Delphinula, *Lamarck* (Liotia, *Gray*. Collonia, *Gray*). Cyclostrema, *Marryat* (Adeorbis, *S. Wood*. Vitrinella, *C. B. Adams*). Euomphalus, *Sowerby*. Ophileta, *Vanuxem*. Phanerotinus, *J. Sowerby*. Stomatella, *Lamarck*. Gena, *Gray*. Broderipia, *Gray*.

Haliotidæ.—Haliotis, *Linnæus*. Stomatia, *Lamarck*. Scissurella, *D'Orbigny*. Pleurotomaria, *Défrance*. Catantostoma, *Sandberger*. Murchisonia, *D'Archiac*. Trochotoma, *Lycett*. Cirrus, *Sowerby*.

Ianthinidæ.—Ianthina, *Lamarck*. Rhaphistoma, *Hall*. Scalites, *Conrad*. Holopea, *Hall*. ? Recluzia, *Petit*.

Fissurellidæ.—Fissurella, *Lamarck* (Pupillia, *Gray*. Fissurellidæa, *D'Orbigny*. Lucapina, *Gray*). Macroschisma, *Swainson*. Puncturella, *Lowe*. Rimula, *Défrance*. Emarginula, *Lamarck* (Hemitoma, *Swainson*). Deslongchampsia, *M'Coy*. Parmophorus, *Blainville*.

Neritidæ.—Nerita, *Linnæus*. Neritoma, *Morris*. Neritopsis, *Grateloup*. Velates, *Montfort*. Pileolus, *J. Sowerby*. Neritina, *Lamarck*. Navicella, *Lamarck*.

SCUTIBRANCHIATA.

Patellidæ.—Patella, *Linnæus* (Nacella, *Schumacher*. Scutellina, *Gray*). Acmæa, *Eschscholtz*, 1830 (Lepeta, *Gray*. Pilidium, *Forbes*). Gadinia, *Gray*. ? Siphonaria, *Blainville*.

Dentaliadæ.—Dentalium, *Linnæus*.

Chitonidæ.—Chiton, *Linnæus* (Tonicia, *Gray*. Acanthopleura, *Guilding*. Mopalia, *Gray*. Katharina, *Gray*. Cryptochiton, *Gray*. Acanthochites, *Leach*. Chitonellus, *Lamarck*). Helminthochiton, *Salter*.

PULMONIFERA.

(*In-Operculata.*)

Helicidæ.—Helix, *Linnæus* (Acavus, *Montfort*. Geotrochus, *Hasselt*. Polygyra, *Say*. Tridopsis, *Rafinesque*. Carocolla, *Lamarck*). Anastoma, *Fischer*. Streptaxis, *Gray*. Sagda, *Beck*. Helicella, *Lamarck*. Stenopus, *Guilding* (Pfeifferia, *Gray*). Vitrina, *Draparnaud* (Daudebardia, *Hartmann*. Simpulopsis, *Beck*). Succinea, *Draparnaud*. Omalonyx, *D'Orbigny*. Bulimus, *Scopoli* (Bulimulus, *Leach*. Odontostomus, *Beck*. Pachyotis, *Beck*. Gibbus, *Montfort*). Partula, *Férussac*. Achatina, *Lamarck* (Zua, *Leach*. Azeca, *Leach*. Tornatellina, *Beck*. Cionella, *Hartmann*). Glandina, *Schumacher*. Spiraxis, *C. B. Adams*. Achatinella, *Swainson*. Pupa, *Lamarck* (Vertigo, *Müller*). Cylindrella, *Pfeiffer*. Balea, *Prideaux*. Megaspira, *Lea*. Clausilia, *Drapernaud*.

Limacidæ.—Limax, *Linnæus*. Geomalacus, *Allman*. Arion, *Férussac*. Parmacella, *Cuvier*. Testacella, *Cuvier*.

Limnæidæ.—Limnæa, *Lamarck*. Amphipeplea, *Nilsson*. Chilinia, *Gray*. Physa, *Draparnaud* (Physopsis, *Krauss*. Camptoceras, *Benson*). ? Camptonyx, *Benson*. Ancylus, *Geoffroy* (Velletia, *Gray*). ? Latia, *Gray*. Gundlachia, *Pfeiffer*. Planorbis, *Müller* (Planorbula, *Haldemann*).

Auriculidæ.—Auricula, *Lamarck* (Polydonta, *Fischer*. Melampus, *Montfort*. Conovulus, *Lamarck*). Pedipes, *Adanson*. Otina, *Alder*. Carychium, *Müller*.

Operculata.

Cyclostomidæ.—Cyclostoma, *Lamarck* (Otopoma, *Gray*. Choanopoma, *Pfeiffer*. Cistula, *Gray*. Realia, *Gray*. Pomatias, *Studer*). Ferussina, *Grateloup*. Cyclophorus, *Montfort* (Pterocyclos, *Benson*. Aulopoma, *Troschel*. Opisthoporus, *Benson*. Cyclotus, *Guilding*. Leptopoma, *Pfeiffer*. Megalostoma, *Guilding*. Craspedopoma, *Pfeiffer*. Cataulus, *Pfeiffer*). Rhaphaulus, *Benson*. Diplommatina, *Benson* (Paxillus, *H. and A. Adams*). Pupina, *Vignard* (Rhegostoma, *Hasselt*. Callia, *Gray*. Pupinella, *Gray*).

Helicinidæ.—Helicina, *Lamarck* (Lucidella, *Gray*. Trochatella, *Swainson*. Alcadia, *Gray*). Proserpina, *Guilding*. Stoastoma, *C. B. Adams*.

Aciculidæ.—Acicula, *Hartmann*. Geomelania, *Pfeiffer*.

TECTIBRANCHIATA.

Tornatellidæ.—Tornatella, *Lamarck* (Cylindrites, *Lycett*. Acteonina, *D'Orbigny*. Acteonella, *D'Orbigny*). Cinulia, *Gray*. Ringicula, *Deshayes*. Globiconcha, *D'Orbigny*. Varigera, *D'Orbigny*. ? Tylostoma, *Sharp*. Pterodonta, *D'Orbigny*. Tornatina, *A. Adams*. ? Volvula, *A. Adams*. ? Volvaria, *Lamarck*.

Bullidæ.—Bulla, *Lamarck* (Cryptophthalmus, *Ehrenberg*. Phanerophthalmus, *A. Adams*. Smaragdinella, *A. Adams*. Acera, *Müller*. Cylichna, *Lovén*. Amphisphyra, *Lovén*. Aplustrum,

Schumacher). Scaphander, *Montfort*. Philine, *Ascanius*, 1772 (Chelidonura, *A. Adams*).

Aplysidæ.—Aplysia, *Gmelin* (Aclesia, *Rang*). Dolabella, *Lamarck*. Icarus, *Forbes*, 1843. Lobiger, *Krohn*.

Pleurobranchidæ.—Pleurobranchus, *Cuvier*. Umbrella, *Chemnitz*. Tylodina, *Rafinesque*.

NUCLEOBRANCHIATA.

Firolidæ.—Carinaria, *Lamarck*. Cardiapoda, *D'Orbigny*.

Atlantidæ.—Atlanta, *Lesueur*. Oxygyrus, *Benson*. ? Calcarella, *Souleyet*. Porcellia, *Léveillé*. Bellerophon, *Montfort*. Bellerophina, *D'Orbigny*. Cyrtolites, *Conrad*. Ecculiomphalus, *Portlock*. ? Maclurea, Lesueur.

PTEROPODA.

(*Aporobranchiata*.)

THECOSOMATA.

Hyaleidæ.—Hyalea, *Lamarck*. Cleodora, *Peron and Lesueur*. Creseis, *Rang*. Cuvieria, *Rang*. Vaginella, *Daudin*. Theca, *Morris*, 1845. Pterotheca, *Salter*. Conularia, *Miller* (Coleoprion, *Sandberger*). Cymbulia, *Peron and Lesueur*.

Limacinidæ. — Limacina, *Cuvier*. Spiralis, *Eydoux and Souleyet*.

BRACHIOPODA, *Cuvier*, 1805.

PALLIOBRANCHIATA.

Terebratulidæ.—Terebratula, *Bruguière* (Terebratulina, *D'Orbigny*. Waldheimia, *King*). Terebratella, *D'Orbigny* (Trigonosemus, *König*. Lyra, *Cumberland*, 1816. Magas, *Sowerby*. Bouchardia, *Davidson*. Morrisia, *Davidson*. Kraussia, *Davidson*. Megerlia, *King*). Argiope, *Deslongchamps*. Thecidium, *Défrance*. Stringocephalus, *Défrance*.

, *Sowerby* (Spiriferina, *D'Orbigny*). Cyrtia, *Dalman* (Cyrtina, *David*-*s*). Athyris, *M'Coy* (Merista, *Suess*). Retzia, Uncites, *Défrance*.

Rhynchonellidæ. — Rhynchonella, *Fischer* (? Porambonites, *Pander*. Camarophoria, *King*). Pentamerus, *Sowerby*. Atrypa, *Dalman*.

Orthidæ.—Orthis, *Dalman* (Orthisina, *D'Orbigny*). Strophomena, *Blainville* (Leptæna, *Dalman*. Koninckia, *Suess*). Davidsonia, *Bouchard*. Calceola, *Lamarck*.

Productidæ.—Producta, *Sowerby* (Aulosteges, *Helmersen*. Strophalosia, *King*). Chonetes, *Fischer*.

Craniadæ.—Crania, *Retzius*.

Discinidæ.—Discina, *Lamarck* (Trematis, *Sharpe*). Siphonotreta, *Verneuil*), Acrotreta, *Kutorga*.

Lingulidæ.—Lingula, *Bruguière*. Obolus, *Eichwald*.

CONCHIFERA.

BRANCHIATA.

(*Asiphonida*.)

Ostreidæ. — Ostrea, *Linnæus*. Gryphæa, *Lamarck*. Exogyra, *Sowerby*.

Anomiadæ.—Anomia, *Linnæus*. *Broderip*. Limanomia, Placuna, *Solander* (Carolia, *Cantraine*, 1835. Placunopsis, *Morris and Lycett*.)

Pectinidæ.—Pecten, *Müller* (Neithea, *Drouet*. Pallium, *Schumacher*. Hinnites, *Défrance*. Hemipecten, *A. Adams*). Lima, *Bruguière* (Limatula, *S. Wood*. Limæa, *Bronn*). Spondylus, *Linnæus* (Pedum, *Bruguière*). Plicatula, *Lamarck*.

Aviculidæ.—Avicula, *Bruguière* (Meleagrina, *Lamarck*. Malleus, *Lamarck*). Vulsella, *Lamarck*. Pteroperna, *Lycett*, 1852. Ambonychia, *Hall*, 1847. ? Cardiola, *Broderip*, 1844. ? Eurydesma, *Morris*. Pterinea, *Goldfuss*, 1832. Monotis, *Bronn*, 1830. Posidonomya, *Bronn*. Aviculo-pecten, *M'Coy*, 1852. Gervillia, *Défrance* (Bakewellia, *King*). Perna, *Bruguière*). Crenatula, *Lamarck*. Hypotrema, *D'Orbigny*, 1853. Inoceramus, *Sowerby*, 1814. Pinna, *Linnæus* (Trichites, *Lycett*).

Mytilidæ.—Mytilus, *Linnæus* (Septifer, *Recluz*). Myalina, *Koninck*, 1842. Modiola, *Lamarck*. Lithodomus, *Cuvier*. Crenella, *Brown*. Modiolarca, *Gray*. ? Mytilimeria, *Conrad*. Modiolopsis, *Hall*, 1847. Orthonotus, *Conrad*. ? Goniophora, *Phillips*. Dreissenia, *Van Beneden*.

Arcadæ.—Arca, *Linnæus*. Cucullæa, *Lamarck* (Macrodon, *Lycett*. Isoarca, *Münster*). Pectunculus, *Lamarck*. Limopsis, *Sassi*, 1827 (Nucunella, *D'Orbigny*). Nucula, *Lamarck* (Nuculina, *D'Orbigny*. Ctenodonta, *Salter*. Cucullella, *M'Coy*. Leda, *Schumacher*, Yoldia, *Möller*). Solenella, *G. Sowerby*. Solemya, *Lamarck*.

Trigoniadæ.—Trigonia, *Bruguière*. Myophoria, *Bronn*, 1830. Axinus, *Sowerby*, 1821. Lyrodesma, *Conrad*, 1841. Verticordia, *Searles Wood*.

Unionidæ. — Unio, *Retz*. Symphynota, *Sowerby*. Monocondylæa, *D'Orbigny*. Anodon, *Cuvier*. Hyria, *Lamarck*. Castalia, *Lamarck*. Iridina, *Lamarck*. Mycetopus, *D'Orbigny*. Ætheria, *Lamarck*. Mülleria, *Férussac*.

SIPHONATA.

Integropalliata.

Chamidæ.—Chama, *Linnæus*. Monopleura, *Matheron*. Diceras, *Lamarck*. Requienia, *Matheron*.

Hippuritidæ.—Hippurites, *Lamarck*. Radiolites, *Lamarck*, 1801 (Bi-radiolites, *D'Orbigny*). Caprinella, *D'Orbigny*. Caprina, *D'Orbigny*. Caprotina, *D'Orbigny*.

Tridacnidæ.—Tridacna, *Bruguière*. Hippopus, *Lamarck*.

Cardiadæ.—Cardium, *Linnæus* (Hemicardium, *Cuvier*. Lithocardium, *Woodward*. Serripes, *Beck*. Adacna, *Eichwald*. Conocardium, *Bronn*).

Lucinidæ.—Lucina, *Bruguière*. Cryptodon, *Turton*. Corbis, *Cuvier*. Sphæra, *Sowerby* (Unicardium, *D'Orbigny*). Tancredia, 1850. Diplodonta, *Bronn*. Scacchia, *Pi* 1844. Cyamium, *Philippi*, 1845. Ungulina, *Daudin*. Kellia, *Turton*. Turtonia, *Hanley*. Pythina, *Hinds*. Montacuta, *Turton*.

Lepton, *Turton.* Scintilla, *Deshayes.* Galeomma, *Turton.*

Cycladidæ.—Cyclas, *Bruguière* (Pisidium, *Pfeiffer*). Cyrena, *Lamarck* (Corbicula, *Mühlfeldt*). Cyrenoides, *Joannis.*

Astartidæ.—Astarte, *Sowerby,* 1816. Opis, *Défrance.* Gouldia, *C. B. Adams.* Crassatella, *Lamarck.*

Cyprinidæ.—Cyprina, *Lamarck.* Circe, *Schumacher.* Isocardia, *Lamarck.* Cypricardia, *Lamarck.* Coralliophaga, *Blainville.* Cypricardites, *Conrad.* Pleurophorus, *King,* 1848. ? Cardilia, *Deshayes.* ? Megalodon, *J. Sowerby.* Goldfussia, *Castlenau.* Megaloma, *Hall,* 1852. Pachydomus, *J. Sowerby.* Pachyrisma, *Morris and Lycett.* Cardinia, *Agassiz.* Anthracosia, *King,* 1844. Myoconcha, *J. Sowerby.* Hippopodium, *Coneybeare.* Cardita, *Bruguière* (Venericardia, *Lamarck*).

SINU-PALLIATA.

Veneridæ.—Venus, *Linnæus* (Saxidomus, *Conrad*). Cytherea, *Lamarck* (Meroe, *Schumacher.* Trigona, *Mühlfeldt.* Grateloupia, *Desmoulin*). Artemis, *Poli* (Cyclina, *Deshayes.* Clementia, *Gray*). Lucinopsis, *Forbes.* Tapes, *Mühlfeldt.* Venerupis, *Lamarck.* Petricola, *Lamarck.* Glaucomya, *Gray.*

Mactridæ.—Mactra, *Linnæus.* Gnathodon, *Gray.* Lutraria, *Lamarck* (Resania, *Gray*). Anatinella, *G. Sowerby.*

Tellinidæ.—Tellina, *Linnæus* (Tellinides, *Lamarck*). Gastrana, *Schumacher.* Capsula, *Schumacher.* Psammobia, *Lamarck.* Quenstedtia, *Morris and Lycett.* Sanguinolaria, *Lamarck.* Semele, *Schumacher* (Cumingia, *G. Sowerby.* Syndosmya, *Recluz.* Scrobicularia, *Schumacher*). Mesodesma, *Deshayes* (Anapa, *Gray*). Ervilia, *Turton.* Sowerbya, *D'Orbigny.* Donax, *Linnæus* (Amphichæna, *Philippi*). Iphigenia, *Schumacher.* Galatea, *Bruguière.*

Solenidæ.—Solen, *Linnæus* (Cultellus, *Schumacher.* Ceratisolen, *Forbes*). Machæra, *Gould.* Solecurtus, *Blainville.* Novaculina, *Benson.* Glycimeris, *Lamarck.*

Myacidæ.—Mya, *Linnæus.* Corbula, *Bruguière.* Potamomya, *J. Sowerby.* Sphenia, *Turton.* Thetis, *Sowerby* (Eucharis, *Recluz*). Panopæa, *Menard de la Groye.*

Anatinidæ.—Anatina, *Lamarck.* Periploma, *Schumacher.* Cercomya, *Agassiz.* Thracia, *Blainville.* Pholadomya, *G. Sowerby.* Myacites, *Bronn.* Goniomya, *Agassiz.* Grammysia, *Verneuil.* Sedgwickia, *M'Coy.* Ceromya, *Agassiz.* Gresslya, *Agassiz.* Cardiomorpha, *Koninck.* Edmondia, *Koninck.* Lyonsia, *Turton,* 1822. Entodesma, *Philippi.* Pandora, *Bruguière.* Myadora, *Gray.* Myochama, *Stutchbury.* Chamostrea, *Roissy.*

Gastrochænidæ.—Gastrochæna, *Spengler,* 1783. Chæna, *Retz,* 1788. Saxicava, *Bellevue.* Clavagella, *Lamarck.* Aspergillum, *Lamarck.*

Pholadidæ.—Pholas, *Linnæus.* Pholadidea, *Turton,* 1819 (Martesia, *Blainville.* Jouannetia, *Desmoulin.* Parapholas, *Conrad*). Xylophaga, *Turton.* Teredo, *Adanson* (Furcella, *Lamarck*). Teredina, *Lamarck.*

Malacone (Gr. μαλακός). A mineral having the form of Zircon, to which it is also nearly related in composition.

Malacopteri (Gr. μαλακός, and πτερόν, *a feather*). An order of fishes in which the endoskeleton is ossified; the exoskeleton, in most as cycloid, in a few as ganoid, scales; fins supported by rays, all save the first sometimes in the dorsal and pectoral, soft and jointed; abdominal or apodal; gills free, operculate; a swim-bladder and air-duct. To this order belong the eel, herring, salmon, pike, and carp genera.

Malacosteon (Gr. μαλακός, and ὀστέον, *a bone*). A diseased softening of the bones: *mollities ossium.*

Malacostracans (Gr. μαλακός, and ὄστρακον, *a shell*). The name of a division of the class Crustaceans, including those which are covered with a crust softer than the shell of the molluscs, but firmer than the covering of the ENTOMOSTRACANS [which see]. The term *Malacostraca* was first applied by Aristotle to the Crustacea of the moderns, being used by him in a comparative sense, as contrasted with the *Ostracoderma,* which are the modern *Testacea.*

Malagma (Gr. from μαλάσσειν, *to soften*). A poultice.

Malaria (Ital. mal' aria, *bad air*). The exhalation of marshy districts, which produces intermittent fevers. This term has now become of general application to deleterious emanations from decaying organic matter; but it was long restricted to emanations in that district of Italy which extends from Leghorn to Terracina in one direction, and from the sea to the Apennines in another. Even in the time of Horace, Rome was deserted two months in the year, on account of the dangers of the malaria. On the Italian malaria, see Arnold's *History of Rome,* chap. xxiii.

Maleic Acid. An acid, isomeric with fumaric acid, obtained by distilling malic acid at a temperature of about 400°. It crystallises in oblique rhombic prisms, which are colourless and inodorous, but sour to the taste. They melt at 266° Fahr.

Malesherbiaceæ (Malesherbia, one of the genera). A small unimportant order of Violal Exogens, related to Passion-flowers, and found in Chili and Peru.

Malic Acid (Lat. malum, *an apple*). A peculiar acid contained in the juice of the apple and several other fruits; it may be obtained also from the berries of the *Sorbus aucuparia,* or Mountain Ash, and has hence been called *sorbic acid.* It crystallises in colourless prisms, which are sour to the taste, and soluble in water and in alcohol.

Malice (Lat. malitia, from malus, *bad*). In the English Law, malice does not necessarily bear the signification of particular ill-feeling towards an individual, but is a term directly importing wickedness in the commission of an act, and excluding a just cause or excuse. [MURDER.] Malicious injury to property is in some instances a felony, in others a misdemeanour. [LAW,

CRIMINAL.] As a general rule in criminal law, acts done wilfully are assumed to be done maliciously. (F. Stephens *On Crim. Law*.) In civil actions for injuries to which malice is essential, e.g. slander, libel, &c., the question of the existence of malice is one, in general, for the jury; but, under certain circumstances, it may be implied by the court from the absence of reasonable and probable cause, as in actions for malicious prosecution.

Malleability (Lat. malleus, *a hammer*). The property of being susceptible of extension under the blows of a hammer. It is especially characteristic of some of the metals, and in this quality gold exceeds all the others: common gold leaf is not more than a two hundred thousandth part of an inch in thickness; five grains may be thus extended so as to cover a surface of more than 270 square inches.

Malleus (Lat. *a hammer*). One of the small bones of the internal ear, attached to the *membrana tympani*, somewhat in shape resembling a hammer.

MALLEUS. A genus of Ostracean bivalves, characterised by having, in addition to the simple pit for the ligament, a notch on the side of the ligament for the passage of a byssus. The species of this genus are called *hammer oysters*. The most noted is the *Ostrea malleus* of Linnæus, which has the cardinal region of the shell formed something like the head of a hammer, of which the elongated valves, extended transversely, represent the handle. It is a native of the Indian Archipelago, and still ranks among the number of rare and high-priced shells.

Mallotus. The capelan, capling, or angmarset, a small fish found in the northern hemisphere, and used as bait for cod. It is interesting as being frequently found in a fossilised state, contained in solid nodules of stone.

Mallow (Lat. malva). A weed common by hedgerows and waysides in Europe. It has mucilaginous properties, and has been employed in the preparation of emollient poultices, in the same way as the Marsh Mallow. Its fruit is a depressed disc, and is called by the country people *cheeses* (Fr. *fromageon*). [MALVA.]

Mallum. The public assembly or meeting of the people according to the usage of the old Teutonic nations. Under the Carlovingian monarchs the mallum appears to have been summoned by the missus or deputy of the sovereign. There was a separate mallum for every leading state or kingdom which composed the empire; and it was attended by the notables of all the various races of inhabitants (Roman, Frankish, Gothic, &c.), and in some instances by the Scabini or Echevins, who represented the communities of the towns.

Malm Bricks. A kind of brick used in London for ornamental works, obtained by the burning of a clay containing carbonate of lime in intimate mixture with the silicate of alumina. It can be easily made by mixing the clay with a portion of chalk; but the best bricks are obtained by the calcination of the natural marls of Essex and Suffolk; the first are of a yellow colour, the second a creamy white. They are easily cut, and on this account are used for arches with a small radius of curvature.

Malmsey (so called as having been made at Malvasia in the Morea). A strong and fine-flavoured sweet wine, made, in Madeira, of grapes which have been allowed to shrivel upon the vine; it is of a deep golden hue. It contains between 16 and 17 per cent. of alcohol.

Malpighiaceæ (Malpighia, one of the genera). An extensive natural order of hypogynous Exogens of the Sapindal alliance, distinguished by their complete (partially symmetrical) flowers, with an imbricated calyx and naked stalked petals, by their simple stigma, by their ovules hanging by cords, and by their usually convolute embryo. They are chiefly tropical, and the larger portion of them are found in South America. The *Byrsonimas* are astringent, and their bark is commonly used for tanning in Brazil. The fruit of some of the *Malpighias* is eaten. *Nitraria tridentata*, another plant of the order, is considered to be the Lotus-tree of the ancients.

Malpighian. In Anatomy, this term is applied to certain parts, especially of the kidney, in allusion to the anatomist Malpighi, by whom they were discovered or first definitely described. Thus the numerous secreting tubes (*tubuli uriniferi*), where they are collected into conical bundles, form the *Malpighian* cones or pyramids; the more tortuous parts of the tubes, which pass towards the surface of the kidney, terminate in, or bear on small pedicles appended to their walls, flask-shaped sacculi, named *Malpighian capsules*. The arteries of the kidney, before dividing into capillaries, form, by tortuous convolutions, little balls, called *Malpighian corpuscles or glomerules*.

Malt (Gr. malz, from malen, *to grind*). This word is used to designate grain which has become sweet in consequence of incipient germination. [DIASTASE.] Malt forms the principal ingredient in the manufacture of beer. Three different kinds are employed: 1. pale or amber malt; 2. brown or blown malt; and 3. roasted or black malt, the fermentation of which yields beer or porter of varying depth of colour.

The manufacture of malt has been carried on for ages in countries where the climate is too cold for the growth of the vine. Beer is spoken of by Xenophon, in his history of the retreat of the Ten Thousand, and was well known to the Romans as the beverage of Northern Europe. Wheat, rye, and oats have at different times been used for malting purposes, but in modern times it is almost entirely manufactured from the various species of barley. By the statute of Elizabeth directing the reservation of a portion of the fixed incomes of corporations in corn rents, malt is selected as one of the articles the highest price of which at Michaelmas and Lady-day is to

form the estimate of the rent for the ensuing year. Malt was first made to contribute to the public revenue in England in 1697, in Scotland in 1713, and in Ireland in 1785. The present duty on malt from barley is 2*s.* 7*d.* per bushel, and from bere or bigg 2*s.* The quantity of malt charged with duty in the United Kingdom during the fifteen years ending 1864, averaged nearly 500,000,000 bushels; and the revenue derived from it averaged in the same period 6,000,000*l.*

The duties levied upon malt have been attacked during the last few years, both in parliament and without it, so energetically, that elections have frequently turned upon the answers given by candidates for a seat in the legislature, as to the justice and necessity of effecting a total and unconditional repeal of those duties. At present the action of those who are unfriendly to the continuance of the tax has been ineffectual, owing, it would appear, chiefly to the difficulty of suggesting an adequate substitute for so important a branch of public revenue.

It is alleged that, in addition to the vexatious interference of all excise duties with the process of manufacture, a greater loss is incurred in a tax levied on what is virtually a raw material, than the proceeds of the tax imply; that the fact of the amount collected being almost a fixed sum from year to year, suggests that it checks consumption, the increase in population not having been followed by an increased demand for ale and beer; that the malt tax discourages private brewing, and throws the manufacture of beer entirely into the hands of brewers; that the tax prevents the employment of capital on such light lands as are particularly suitable for the growth of barley, and is therefore an impediment to the developement of agricultural prosperity; that malted grain is particularly serviceable for fattening cattle, and that the existence of the tax is a hindrance to the improvement of stock, by making the time in which such stock can be available for consumption unnecessarily protracted; and that generally the malt tax is an offence against the principles of free trade and the admitted canons of taxation.

In reply, it is stated that the process of malting is so simple that excise regulations are reduced to the barest supervision over the quantity manufactured, and that a very short time is interposed between the incidence of the tax and the consumption of the product; that the sum paid is certainly uniform from year to year, but that the consumption of other articles analogous to beer and ale, and substituted for them, is the real reason why the malt revenue does not grow with population; that, granting the propriety of taxing alcoholic liquids, beer and ale are, considering the alcohol they contain, the most lightly taxed of all such substances, and that the abandonment of all duties on malt would be unfair to the distiller and the wine grower, and, what is of more importance, to the consumer; that even now private brewing may be resorted to, but that, notwithstanding the fact that the trade of a common brewer is subject to additional duties, the advantage of the public is really consulted, and that what is called *teapot brewing* is relinquished because the product is really dearer and more uncertain: that there is no reason to think that private brewing would be adopted on the abolition of the malt duty, since private baking was not resorted to on the abolition of the corn laws; that a considerable rise has taken place of late years in the price of barley, and that therefore a sufficient stimulant is supplied to the cultivation of barley-growing soils; that malted grain is not serviceable for fattening cattle, the loss of weight and nutritive power in the process of malting amounting to at least 20 per cent., and that the abolition of the duty would have no beneficial effect on the art of breeding and fattening stock; and that, lastly, all taxes are more or less against the principles of free trade, but that those taxes are to be retained for revenue purposes which are the least mischievous and the most fair in their incidence, and that such is eminently the case with the malt tax.

Barley may, by an Act of the last session, be malted for feeding purposes under certain regulations.

Maltha (Gr. and Lat.). A mineralogical term applied to *mineral pitch*; an inflammable bituminous product, probably derived from the exsiccation of mineral tar. A cement containing mineral pitch was used by the ancients for plastering their walls, and was composed of pitch, wax, plaster, and grease. Another sort, with which the Romans used to plaster the interior of their aqueducts, was made of lime incorporated with melted pitch. The various bituminous pavements which have lately come into use are similar combinations.

Malthacite. A white tallow-like mineral from Lobau.

Malva (Gr. *μαλάχη, a mallow*). A genus of *Malvaceæ* abundant by waysides. The common Mallow, *M. sylvestris*, is mucilaginous; its dried flowers are used in France in the preparation of a drink called Tisane or Ptisan, which is regarded as a cure for feverish colds and other ailments. This plant is the *Mauve* of the French, and from its fading flowers has been derived the name of the colour so called. *M. rotundifolia* is in some countries used as a potherb.

Malvaceæ (Malva, one of the genera). A natural order of mucilaginous Exogenous plants of the Malval alliance, with polypetalous flowers and monadelphous stamens. The species are herbs, bushes, or trees, and are found all over the temperate and tropical parts of the world, especially the latter. Their flowers are in many cases large and handsome; but the order is chiefly interesting from containing the *Gossypium* or Cotton-plant. Another species is the Marsh Mallow, *Althæa officinalis*. Some yield a fibre fit for manufacture into cordage. *Hi-*

biscus cannabinus yields Indian Hemp; and *Paritium elatum* furnishes Cuba Bast.

Mameluke (Arab. memalik, *a slave*). A name applied to the male slaves imported from Circassia into Egypt by the master of that country. In the thirteenth century, when the countries in the vicinity of Mount Caucasus were ravaged by Gengis Khan, Nojmedden, sultan of Egypt, purchased several thousands of the natives of those regions, especially Turks, and formed them into an armed body of guards. These guards or Mamelukes, in the sequel, seized on all the power of the country, murdered the sultan Touran Shah, A. D. 1258, and made Ibeg, one of their own number, his successor. After that period the Mamelukes, whose numbers were continually increased by importations from their own country, governed Egypt 263 years. (Gibbon, ch. lix.) This military sovereignty was destroyed by Selim I., the Turkish sultan who took Cairo in 1517. Nevertheless, the Mamelukes, under their twenty-four beys, continued for 200 years more to exercise a power scarcely inferior to that of the Turkish pachas, whom, in the eighteenth century, they reduced to mere ciphers in the government. Their power was again considerably broken by the French invasion under Bonaparte, to whom they offered a determined opposition. After the abandonment of Egypt by the French, the struggle between the beys and the pachas was renewed: finally, in 1811, the pacha, Mohammed Ali, having invited the principal leaders of the Mamelukes to a banquet, slew 470 of them by treachery, and compelled the remainder to submission.

Mammalia (Lat. mamma, *a teat*). The most highly organised class of animals, at the head of the great scale of organised nature. They possess mammary glands, and suckle their young; the fœtus is developed in the womb. Their external distinguishing marks are a covering of hair, and teats or nipples; but to the manifestation of these two characters there are a few exceptions. The principal anatomical character is the condition of the lungs, which are suspended freely in a thoracic cavity, separated by a perfect diaphragm from the abdomen. The entire tissue of the lungs is occupied by extremely minute air-cells, with highly vascular parietes, so that the air inspired is rapidly changed, and breathing can be safely suspended only for a short time. The whole mass of circulating blood is transmitted to the lungs by the mechanism of a pulmonary auricle and ventricle, equally perfect, and inferior only in power to the systemic auricle and ventricle, which subsequently propel the aërated blood to the general system; the heart consequently consists of four distinct cavities.

The upper jaw of the Mammalia is fixed; the two rami of the lower jaw consist each of a single bony piece, and are articulated by a convex or flat condyle to the base of the zygomatic process, and not the tympanic element of the temporal bone. With a few exceptions the jaws of the Mammalia are armed with teeth: these are arranged in a single row, are lodged in sockets sometimes by two or more fangs, and are never anchylosed to the substance of the jaw. A deciduous tooth is never succeeded by more than one corresponding tooth in the vertical direction. The tongue is fleshy, well developed, with the apex more or less free. The posterior openings of the nasal passages are protected by the *soft palate*, and the larynx, or opening of the wind-pipe, by an *epiglottis*. The alimentary canal varies with the nature of the food, but the *cæcum coli* is usually single. The rectum commonly terminates by a distinct aperture behind the urinary and generative orifices.

The bodies of the vertebræ have their articular surfaces more or less flattened, and always joined together by a series of concentric ligaments with interposed glairy fluid. The cervical vertebræ, with one or two exceptions, are seven in number. The atlas is articulated by two surfaces to two occipital condyles, developed from the ex-occipital elements. With two exceptions in the Monotremata the coracoid bone appears as a small process or appendage of the scapula. The sternum is narrow, and consists of a simple longitudinal series of bones.

The second, or distal bone, called *squamosal*, in the bar continued backwards from the maxillary arch, is not only expanded, but is applied to the side wall of the cranium, and developes the articular surface for the mandible, which surface is either concave or flat. The presphenoid is developed from a centre distinct from the basisphenoid.

The brain presents its highest state of developement in the Mammalia: it consists of a cerebrum, which is generally more or less convoluted, a cerebellum with lateral lobes, and a medulla oblongata with a distinct *tuber annulare*. The optic lobes are solid, divided by a transverse fissure, and hence called *bigeminal bodies*: they are situated on the upper part of the crura cerebri, and are generally concealed by the overlapping posterior cerebral lobes. The rudiment of the *corpus callosum*, or great cerebral commissure, first begins to be distinctly recognisable in the highest Lyencephale Mammalia; and in a state of normal developement, or where it bears a direct proportion to the size of the corpora striata or hemispheres of the brain, it is peculiar to the Lissencephale, Gyrencephale, and Archencephale Mammalia.

The eyes of the Mammalia are never complicated with a pecten or marsupium, a choroid gland, or sclerotic bony plates.

The organ of hearing acquires in the Mammalia a fully developed cochlea with a *lamina spiralis*: there are three distinct ossicles in the tympanum; the drum, or membrana tympani, is usually concave towards the meatus, which generally commences with a more or less complicated external ear, supported by a distinct fibro-cartilage.

The Mammalia, without exception, bring forth their young alive; hence they were termed by Aristotle *Zootoca*. This phenomenon is,

however, by no means peculiar to the present class; but it was supposed that they differed from other viviparous animals, as the viper, in the developement of the germ by means of a placenta. Such, however, is not the case with the marsupial animals, and probably not with the Monotremes; and as the absence of the placenta is associated with several important modifications of structure in the species so developed, by which they approximate to the characters of the oviparous classes, the class Mammalia was primarily divided into two great divisions, called *Placentalia* and *Implacentalia*.

Before, however, the subdivisions are more especially characterised, it may be advantageous to trace the principal steps by which the present views of the affinities and classification of the Mammalia have been acquired.

Aristotle, choosing the locomotive system as a base, divided his *Zootoca*, the equivalent of the Linnæan mammalia, according to the nature of their locomotive organs, into three sections: 1. *Dipoda*, or bipeds; 2. *Tetrapoda*, or quadrupeds; and 3. *Apoda*, or impeds. Man is cited as the type of the first, and the whale tribe is included in the last of these primary groups; the second embraces all the rest of the class, which, in common language, are called *quadrupeds*. These Aristotle subdivided into two great natural groups, according to the modifications of the organs of touch. In the first a part of the digits is left free for the exercise of the tactile faculty, the nail or claw being placed upon one side only; in the second group the extremities of the digits are enclosed in hoofs.

These again are subdivided, the first group, or *Unguiculata* of modern mammalogists, into: 1. Those which have the front teeth trenchant, and the back teeth flattened, as the *Pithecoida* or apes, and the *Dermaptera* or bats; 2. Those with acuminated trenchant or carnivorous teeth, which Aristotle calls *Karcharodonta*; 3. The Rodent quadrupeds, which are indicated by a negative dental character. With respect to the hoofed or *ungulate* quadrupeds, Aristotle points out subordinate groups, and characterises them by modifications of the feet. Thus, the first are the *Polyschidæ* or multungulate quadrupeds, as the elephant; the second are the *Dischidæ* or bisulcate quadrupeds, as the Ruminants and hog; the third are the *Aschidæ* or solidungulate quadrupeds, as the horse and ass.

Ray, with a less philosophical appreciation of the extent and nature of the class Zootoca or Mammalia, arranges his equivalent group of 'Viviparous four-footed animals' chiefly on the Aristotelian characters, the primary divisions being the *Unguiculata* and *Ungulata*, and the subdivisions being based on locomotive and dental characters. The whales are excluded.

Linnæus, restoring the class Mammalia to its Aristotelian integrity, primarily subdivides it into *Unguiculata*, *Ungulata*, and *Mutica*, the latter being the equivalent of the *Apoda* of Aristotle; but his secondary divisions or orders are taken chiefly from modifications of the dentary system. The following is the scheme of his arrangement:—

Mammalia.

Unguiculata	Front teeth, none in either jaw	*Bruta.*
	Front teeth, *cutters* 2, laniaries 0	*Glires.*
	Front teeth, *cutters* 4, laniaries 1	*Primates.*
	Front teeth, *piercers* (6, 2, 10), laniaries 1	*Feræ.*
Ungulata	Front teeth, in both upper and lower jaw	*Belluæ.*
	Front teeth, none in the upper jaw	*Pecora.*
Muticate	Teeth variable	*Cete.*

(From the *Systema Naturæ*, ed. 16, Holmiæ, p. 24.)

Linnæus defines the class Mammalia as follows: *Heart* with two auricles and two ventricles; blood warm; *lungs* respiring reciprocally (*pulmones respirantes reciproce*); *jaws* incumbent, covered, armed with teeth in most; *penis intrans*; generation viviparous, lactiferous; *senses*, tongue, nostrils, eyes, ears, tactile papillæ; *covering*, hairs few in tropical, very sparing in aquatic, mammals; *support*, four feet, except in those which are entirely aquatic, in which the posterior feet are bound together in the fin of the tail; a *tail* in most.

Cuvier, adopting the same threefold primary division of the class, subdivides it into better and more naturally defined orders, according to various characters derived from the dental, the osseous, generative, and the locomotive systems. In giving the outline of this method, Cuvier developes the principles on which his divisions are founded.

'The characters by which Mammalia differ most essentially one from another are derived from the organs of touch, from which results their degree of dexterity; and from the organs of mastication, which determine the nature of their food; and upon these very closely depends not only everything which is connected with the digestive functions, but a variety of other circumstances relative even to their degrees of intelligence.

'The perfection of the organs of touch is estimated by the number and mobility of the digits, and the extent to which they are enclosed in a claw or in a hoof. A hoof which completely encloses that part of the digit which touches the ground precludes the exercise of it as an organ of touch or of prehension. The opposite extreme is where the nail, in the form of a simple lamina, covers only one side of the end of the digit, leaving the other side in possession of all its delicacy of tact.

'The kind of food is indicated by the molar teeth, to the form of which the articulation of the jaws invariably corresponds.

'For cutting flesh, the molar teeth must be trenchant and serrated; and the jaws fitted together, so as to move like the blades of a pair of scissors, simply opening and closing in the vertical direction.

'For bruising grains and roots, the molar teeth must have flattened crowns, and the jaws

a horizontal motion; and further, that the grinding surface may be always unequal, like a millstone, the teeth must be composed of substances of different degrees of density, and consequently wearing down in different proportions.

'The ungulate quadrupeds are all of necessity herbivorous, or with flat-crowned molares, because the conformation of their feet does not permit them to seize living prey.

'The unguiculate animals are susceptible of more variety. They are not limited to one kind of food; and besides the consequent variation in the form of their molares, they differ materially from each other in the mobility and sensibility of their digits. There is, moreover, a characteristic which prodigiously influences their dexterity, and gives variety to their modes of action: it is the faculty of opposing a thumb to the other fingers, so as to seize the smallest objects, which constitutes a *hand*, properly so called. This faculty is carried to its highest degree of perfection in man, in whom the whole anterior extremity is free, and can be exclusively employed in prehension. These different combinations, which strictly determine the nature of the several mammiferous animals, have formed the grounds for their distribution into the following orders:—

'Amongst the unguiculate animals, the first is man, who, in addition to his peculiar privileges in every other respect, is distinguished, zoologically, by possessing hands on the anterior extremities alone, the posterior extremities being destined to sustain him in an erect position.

'The order which comes nearest to man—that termed *Quadrumana*—has hands on the four extremities.

'Another order, termed *Carnivora*, has not the thumb free and opposable on the anterior extremities.

'These three orders possess, likewise, severally, the three kinds of teeth; viz. molars, laniaries, and incisors.

'The quadrupeds of the fourth order, viz. the *Rodentia*, have the digits differing little from those of the *Carnivora*; but they want the laniary teeth, and have the incisors of a form and disposition altogether peculiar to themselves.

'To these succeed the animals whose digits now become much cramped, being sunk deep in large and, most commonly, crooked claws. They are further defective in the absence of incisor teeth; some of them even want the laniaries, and others are altogether destitute of dentary organs. We shall comprehend them under the term *Edentata*.

'This distribution of unguiculate animals would be perfect, and would form a very regular chain,' if New Holland had not lately furnished us with a small collateral chain, composed of the *Marsupial* animals, all the genera of which, while they are connected by a general similarity of organisation, at the same time correspond, in their dentition and diet, some to the *Carnivora*, others to the *Rodentia* and a third tribe to the *Edentata*.

'The ungulate animals are less numerous, and present fewer variations of form.

'The *Ruminantia*, by their cloven feet, their want of upper incisors, and their complicated stomach, form a very distinct order.

'All the other quadrupeds with hoofs might be united into a single order, which I would call *Pachydermata* or *Jumenta*, the elephant excepted, which might form an order of itself, having some remote affinities to the order *Rodentia*.

'Last of all come the *Mammalia*, which have no hinder extremities, and whose fish-like form and aquatic life would induce us to form them into a separate class, if their economy was not in every other respect the same as in the class in which we shall leave them. They are the warm-blooded fishes of the ancients, or the *Cetacea*, which, combining the powers of other Mammalia with the advantage of being sustained upon the watery element, include the most gigantic forms to be found in the whole animal creation.' (*Règne Animal*, 2nd edit. p. 65.)

Illiger, in primarily dividing the Mammalia into those with free and those with fettered limbs—the *pedes exserti distincti* contrasted with the *pedes retracti obvoluti*—made a more unequal and less natural partition than the threefold one of Aristotle. The seals and the whales balance all the rest of the class in the Illigerian system. The subdivisions, also, of these primary groups, based exclusively on characters of locomotion, although frequently ingenious, have met with little acceptance beyond some of the schools of Germany. De Blainville, in 1816, adopted a character from the reproductive system for the primary division of the mammalia, viz. into the *Monodelphes*, *Didelphes*, and *Ornithodelphes*. His orders are in the main a return to the Linnæan system and nomenclature, with some peculiar views, as e.g. of the quadrumanous or primatial affinity of the Sloths, which have never gained acceptance. But his system indicates a clearer appreciation or stronger conviction of the value of the character of parity or imparity in the number of toes of the Ungulata, first suggested by Cuvier, than was subsequently entertained by the originator of the idea. The position of the Marsupial and Monotrematous quadrupeds at the bottom of the class Mammalia, and the higher value assigned to the group which they constituted, than that in the *Règne Animal* of Cuvier, were ideas also in closer conformity with nature.

C. Lucien Bonaparte made the most important improvement in the classification of Mammalia which has been proposed since the establishment of the natural character of the implacental or ovoviviparous division. He, adopting the primary division into *Placentalia* and *Implacentalia*, divided the former into the two subclasses *Educabilia* and *Ineducabilia*, the latter including the orders *Bruta*, *Cheiroptera*, *Insectivora*, and *Rodentia*, with the common character of *cerebrum unilobum*.

Isidore Geoffroy St. Hilaire raises the Marsupialia into a distinct class, and literally exemplifies the idea of Cuvier, by placing its subdivisions as orders in parallel equivalents with the orders of the *Placentalia.*

Sir Everard Home proposed a system of classification of Mammalia according to the modifications of the placenta, which unites many animals by common characters which belong to wholly distinct types of organisation.

Prof. Owen, in 1857, after carefully maturing the observations of many years on the anatomy of the brain, the mode of reproduction of the teeth, the locomotive, generative, and tegumentary characters of Mammalia, laid before the Linnæan Society the following classification, which we reproduce below. The characters of each subclass and order will be found in its proper place.

SUBCLASS ARCHENCEPHALA.

Order 1. *Bimana.*

SUBCLASS GYRENCEPHALA.

A. Unguiculata.

Order 2. *Quadrumana.* Fam. Catarrhina, Platyrrhina, Strepsirhina.

Order 3. *Carnivora.* Fam. Digitigrada, Plantigrada, Pinnigrada.

B. Ungulata.

Order 4. *Artiodactyla.* Fam. Omnivora, Ruminantia.

Order 5. *Perissodactyla.* Fam. Multungula, Solidungula.

Order 6. *Proboscidea.* Fam. Elephantidæ, Dinotheriidæ.

Order 7. *Toxodontia.* Fam. Toxodontidæ, Nesodontidæ.

C. Mutilata.

Order 8. *Sirenia.* Fam. Manatidæ, Halicoridæ.

Order 9. *Cetacea.* Fam. Delphinidæ, Balænidæ.

SUBCLASS LISSENCEPHALA.

Order 10. *Bruta.* Fam. Bradypodidæ, Dasypodidæ, Edentula.

Order 11. *Cheiroptera.* Fam. Frugivora, Insectivora.

Order 12. *Insectivora.* Fam. Talpidæ, Erinaceidæ, Soricidæ.

Order 13. *Rodentia.* Fam. Nonclaviculata, Claviculata.

SUBCLASS LYENCEPHALA.

Order 14. *Marsupialia.* Fam. Rhizophaga, Poëphaga, Carpophaga, Entomophaga.

Order 15. *Monotremata.* Fam. Echidnidæ, Ornithorhynchidæ.

No linear arrangement of the orders of a class can ever express more than a part of their mutual affinities. If we were to place them according to their natural relations, the *Quadrumana* would occupy the centre of the class, as from these the greatest number and variety of affinities seem to radiate. Thus, the genus *Galeopithecus* leads to the *Cheiroptera*, the *Lemur* to the *Carnivora*, the *Loris* to the sloths among the *Edentata*; while with the *Rodentia* the *Lemurs* claim close alliance through the *Cheiromys* or *Aye-aye.*

Amongst the *Carnivora*, *Cercoleptes* approaches the *Lemuridæ*, *Mydaus* the Gymnurine Insectivores, and *Phoca*, *Hippopotamus* and the *Sirenia.* In the *Artiodactyla*, *Camelus* trends off towards *Equus*, *Sus* towards *Centetes*, *Moschus* towards *Dolichotis.* In the *Perissodactyla*, *Hyrax* indicates the Rodent type. The Elephant and the Capybara have some remote analogy, as pointed out by Cuvier. Toxodontia, Sirenia, and Cetacea have many points of analogy inter se. The Bruta have lost in the mailed *Glyptodon* a transitional step to the thick and tubercular-hided rhinoceros; while the *Megatherium* approaches the colossal Pachyderms, the Sloth the Ruminants, and *Manis* and *Orycteropus* respectively the Echidna and Ornithorhynchus. The Rodentia have the same scalpriform molars as the Aye-Aye, the *Hyrax*, the Toxodon, and the Wombat. In the Cheiroptera, whilst *Pteropus* typifies *Galeopithecus*, Vespertilio approaches Sorex. But the most divergent affinities are observed in the Marsupialia. Here the *Dasyuridæ* and *Didelphidæ* typify the Soricidæ, *Chæropus* represents *Macroscelides*, *Perameles* and *Myrmecobius* the *Erinaceidæ*, *Phascolomys Lagostomus*, *Macropidæ* the Jerboas and Hares, *Petaurus* the flying squirrel, *Phalangistidæ Sciurus*, and *Phascolarctus Bradypus.*

In such a reticulate weaving of affinities, under which image the true relations of the Mammalia, as at present known, can alone be impartially and faithfully expressed, it will be observed that the lower the order is in the class, the greater divergence of analogy it offers to the orders above it in the scale. Thus more points of analogy exist between the *Lissencephala* and *Lyencephala* inter se, than between the Unguiculate and Ungulate groups of Gyrencephalate Mammalia.

From different points at the base of this cone the connection may be traced with the inferior classes; the most direct transition appears to be made by the Monotremes to the class of Reptiles. The functions of the warm-blooded mammalia of the tertiary period were fulfilled during the secondary age by reptiles. Thus, in the oolitic seas, the whales were represented by the Ichthyosauria; whilst the extinct Pterodactyles represented the bats. The Mammalia which present the closest relations to birds are the marsupial petaurists and the arboreal Rodents; but the hiatus is great. Between mammals and fishes the reptiles interpose at all points.

Mammalogy (Lat. mamma, and Gr. λόγος). The science of Mammals; the doctrine of their organisation, habits, properties, and classification. [MAMMALIA.]

Mammea (Mamey, its American name). A genus of *Clusiaceæ*, comprising *M. americana*, the fruit of which, under the name of Mammee Apple or South American Apricot, is much es-

teemed in tropical countries. It is as large as a cannon ball, yellow, with the rind, pulp, and seeds bitter, but the intermediate flesh sweet and aromatic. The tree is a native of the West Indies and tropical America, but is cultivated and almost naturalised in some parts of tropical Asia and Africa.

Mammee. The *Lucuma mammosum*, sometimes called Marmalade-tree. It must be distinguished from the Mammee apple of the preceding article.

Mammifers (Lat. mamma, and fero, *I bear*). A term synonymous with Mammals or Mammalia.

Mammon (Syr.). Among the Jews, this word signified riches, or the god of riches. In the *Paradise Lost*, Milton represents Mammon as one of the fallen angels.

Mammoth (a word of Samoied origin, applied in Siberia to burrowing animals). The extinct elephant of Siberia, Northern Europe, and North America. Its remains occur chiefly, if not exclusively, in post-pliocene deposits. Its grinders are broader, and have narrower and more numerous and close-set transverse plates and ridges, than in other elephants. In several of the instances of Mammoth's tusks from British strata, the ivory has been so little altered as to be fit for the purposes of manufacture; and the tusks of the mammoth, which are still better preserved in the frozen drift of Siberia, have long been collected in great numbers as articles of commerce. The mammoth is more completely known than most other extinct animals by reason of the discovery of an entire specimen, preserved in the frozen soil of a cliff at the mouth of the river Lena in Siberia. The skin was clothed with a reddish wool, and with long black hairs. It is now preserved at St. Petersburg, together with the skeleton, to which parts of the skin of the head, the eyeball, the strong ligament of the nape which helped to sustain the heavy head and teeth, and the hoofs, remain attached. The mammoth seems to have enjoyed a wider geographical range than any other extinct elephant. Its remains have been found in the British Isles, continental Europe, the Mediterranean, Siberia, and throughout a large portion of North America, where it coexisted not only with the gigantic *Mastodon ohioticus*, but also with a second species of true elephant (*E. texianus*), the teeth of which were more adapted to a succulent vegetable diet.

Man (a Teutonic word, from the Aryan root man, *to think*; hence Sansc. menu, *a thinker*). Of all living beings on the surface of this planet the first is *man*, who, in addition to his peculiar privileges in every other respect, is distinguished zoologically by possessing a hand on the anterior extremities only, the posterior or lower limbs being destined to sustain him in an erect position. He is, however, naked, and without natural defensive or destructive weapons.

The main points of internal anatomy in which man differs from or excels the lower animals are the following: First of all, in the magnitude of the brain, which is relatively greater than the spinal chord and nerves in him than in any other animal. This superiority is chiefly due to the great developement of the hemispheres of the cerebrum, which are likewise characterised in man by the number and depth of the convolutions, by which the cineritious and vascular surface is augmented. The parts which exist in the human brain to a greater extent than in the lower animals are the posterior lobes of the cerebrum, the corresponding horn of the lateral ventricle, and the lesser hippocampus.

Of the external senses, that of smell is the least developed; but both this and the other organs are well balanced, and in their organisation most delicate and perfect. The two eyes are directed forward; and thus, though man does not see on two sides at once, like many quadrupeds, there is more unity in the result of his vision, and he can concentrate his attention more closely on the objects of his scrutiny. The external ear, having little mobility or extent, does not increase the intensity of sounds; notwithstanding which, Cuvier well remarks that man best distinguishes their intonation. So also with respect to the organ of smell; though most animals excel man in their power of scent for particular objects, there are none perhaps which can distinguish so many varieties of, or which are so uniformly affected by, unpleasant odours. In the discrimination and delicacy of taste man has unquestionably the advantage over the lower animals; and in no species is the hand so framed, or the tactile extremities of the digits so expanded, or endowed with such an exquisitely sensitive and discriminative integument, as in man.

'Man,' says Cuvier, 'has a particular pre-eminence in his organs of voice: he is the only mammal that can articulate sounds; probably on account of the form of his mouth and the great mobility of his lips. Hence results his most valuable mode of communication; for of all signs that can be conveniently employed for the transmission of ideas, varied sounds are those which can be perceived at the greatest distance, and in most directions simultaneously.' [LANGUAGE.]

The position of the heart, which rests obliquely on the diaphragm, and on which depends the absence of the azygos lobe of the right lung, and of the thoracic inferior cava—both which exist in most of the inferior Mammalia—relates to man's erect position.

The alimentary organs of man indicate his natural destination for a mixed diet of animal and vegetable substances; but the prehensile faculty of his hands, and the intelligence which governs its application, permitted the teeth to remain of such forms and proportions as might simply serve to divide and crush the food which the hands carry to the mouth. Thus the canine teeth, though present and with crowns shaped for piercing, do not exceed the adjoining teeth in size, and no interval in the dental series of one jaw is required to receive a pro-

duced tusk of the opposite jaw when the mouth is closed; thus the dental series in man is not only equable, but unbroken. The fore teeth are framed for dividing; the back teeth have flat and tuberculate crowns for bruising; the short and but moderately strong jaws hardly admit of the mastication of herbage, or the devouring of flesh that has not been previously prepared by cooking.

The organs of digestion conform with those of manducation; the stomach is simple; the intestinal canal of mean length; the small intestines are provided with numerous transverse folds of the secreting and absorbing mucous membrane, called *valvulæ conniventes*; the large intestines are well marked; they commence by a short and wide cæcum, provided with a long, slender, and vermiform appendage.

The period of gestation is nine months. In general there is only one child at a birth; twins are born once in about five hundred cases of parturition, and more than that number is extremely rare. The fœtus of seven months is eleven inches in length; that of nine months eighteen inches. Those which are born prior to the seventh month usually die. The first or milk teeth begin to appear a few months after birth, commencing with the incisors; at two years the entire deciduous series, twenty in number, is attained. These are shed successively from about the seventh year, to be replaced by others. The eight deciduous incisors are succeeded by eight permanent ones, the four deciduous canines by four permanent ones; the eight deciduous molares by the eight bicuspides. Of the twelve true or posterior molars, which are permanent, there are four—one on each side of both jaws – that make their appearance at four years and a half; four more at nine years; the last four being frequently not cut until the twentieth year. The fœtus presents one-fourth of the adult stature when born; it has attained one half of it at two years and a half, and three-fourths at nine or ten years. Between the seventeenth and twenty-first years the growth almost entirely ceases. Man rarely exceeds six feet, and seldom remains under five. Woman is ordinarily some inches shorter. When the full stature is attained, the body generally begins to increase in bulk; fat is accumulated in the cellular tissue; afterwards the solids become rigid; the fat is commonly absorbed, the before smoothly-filled integument falls in wrinkles; and old age arrives, with decrepitude, decay, and death. Man rarely lives beyond a hundred years; and most of the species, either from disease, accidents, or merely old age, perish before that term.

'The child,' says Cuvier, 'needs the assistance of its mother much longer than her milk; whence results an education intellectual as well as physical, and a durable mutual attachment. From the long period of infantile weakness results domestic subordination, and, consequently, the order of society at large, as the young persons which compose the new families continue to preserve with their parents those tender relations to which they have been so long accustomed. This disposition to mutual assistance multiplies to an almost unlimited extent those advantages previously derived by isolated man from his intelligence. It has assisted him to tame or repulse other animals, to defend himself from the effects of climate, and thus enabled him to cover the earth with his species. Circumstances, more or less favourable, have restrained the social condition within limited degrees, or have promoted its developement. The glacial climates of the north of both continents, and the impenetrable forests of America, are still inhabited by the savage hunter or fisherman; the immense sandy or salt plains of Central Asia and Africa are covered with a pastoral people and innumerable herds. These half-civilised hordes assemble at the call of every enthusiastic chief, and overrun the cultivated countries that surround them, in which they establish themselves but to become enervated, and to be subjected in their turn to the next invaders. This is the true cause of that despotism which in every age has crushed the industry called forth under the fine climates of Persia, India, and China. Mild climates, soils naturally irrigated, and rich in vegetables, are the natural cradles of agriculture and civilisation; and when their position is such as to afford shelter from the incursions of barbarians, talents of every kind are mutually excited. Such were formerly (the first in Europe) Greece and Italy; and such is at present nearly all the happy portion of the earth's surface.'

The influences of climate, and of the different habits and social conditions thence resulting, are associated with differences of form, stature, features, and colour of the skin; not greater, however, than the corresponding differences which indicate varieties of a species in the lower Mammalia; and accordingly naturalists have distinguished, and have characterised with more or less success, different races or varieties of man. 'As the races and varieties of the domesticated quadrupeds, so also those of the human species, blend imperceptibly with each other; and the absence of well-defined boundaries depends not only on the gradual subsidence and change of those physical causes which probably gave rise to the original varieties, but also to the faculty common to the individuals of different varieties of the same species to produce, by their union, individuals capable of propagating the intermediate variety. Hence has arisen the difficulty of defining the primary races of man, and the discrepancy which exists in the conclusions of those naturalists who have devoted the greatest attention to this important and most interesting branch of zoology. Cuvier considers that *three* varieties are eminently distinct—the white, or *Caucasian*; the yellow, or *Mongolian*; the black, or *Æthiopian*.

'The Caucasian,' he observes, 'to which we belong, is distinguished by the beauty of the

oval which forms the head; and it is this one which has given rise to the most civilised nations—to those which have generally held the rest in subjection. It varies in complexion and in the colour of the hair.

'The Mongolian is known by his projecting cheekbones, flat visage, narrow and oblique eyebrows, scanty beard, and olive complexion. Great empires have been established by this race in China and Japan, and its conquests have sometimes extended to this side of the Great Desert; but its civilisation has always remained stationary.

The Negro or Æthiopian race is confined to the southward of the Atlas chain of mountains. Its colour is black, its hair crisped, the cranium is contracted, and the nose flattened. The projecting muzzle and thick lips evidently approximate it to the apes. The hordes of which it is composed have always continued barbarous.'

To the three primary races characterised by Cuvier, Blumenbach adds the *Malayan* and *American* races. Of the Malays, however, Cuvier asks, 'Can they be clearly distinguished from their neighbours on both sides, the Caucasian Indians and the Mongolian Chinese?' And with regard to the Americans, he states, 'They have no precise or constant character which can entitle them to be considered as a particular race. Their copper-coloured complexion is not sufficient. Their general black hair and scanty beard would induce us to approximate them to the Mongols, if their defined features, their nose as projecting as ours, their large and open eyes, did not oppose such a theory, and correspond with the features of the European.'

Dr. Prichard, however, considered that there are seven classes of nations which may be separated from each other by strongly marked lines.

The *first* class corresponds with Cuvier's Caucasian variety, but which Dr. Prichard prefers to call *Iranian.*

The *second*, which he terms *Turanian*, is equivalent to the Mongolian variety.

The *third* class are the native American races, excluding the Esquimaux and some tribes which resemble them more than the majority of inhabitants of the New World.

The *fourth* class comprises only the Hottentot and Bushman races.

A *fifth* class includes the Negroes.

The *sixth* class consists of the Papuans, or woolly-haired natives of Polynesia.

The *seventh* class includes the Alfourou and Australian races.

The above classification has not generally been adopted.

A study of the resemblances and differences of human speech in various regions and various ages, has added much and will contribute more to the true knowledge and definition of the primitive races of the human species. It has already led to the establishment of the following families of languages: The *Semitic*, to which belong the Hebrew, Arabic, Chaldean, Syrian, Phœnician, and Ethiopian; the Aryan or *Indo-European*, which includes Sanscrit, Persian, Greek, Latin, German, and Celtic; the *Monosyllabic* languages, as Chinese, Thibetan, Birman, Siamese; the *Polysynthetic* languages, a class including most of the American-Indian dialects. The combination of zoological, anatomical, and glossological characters, is still wanting to establish the exact characters and limits of the human races. [ANTHROPOLOGY.]

Manatee or **Manati.** A genus of Sirenian Mammalia, in which the molar teeth have square crowns marked by two transverse ridges. There are no incisors or canines in the adult. Species are known from the tropical seas of both Africa and America.

Manby's Shot. [LIFE-PRESERVING APPARATUS.]

Manchineel (Mancinella, the Spanish name). The *Hippomane Mancinella*, a tree inhabiting the West India islands, and celebrated for its poisonous qualities. It is asserted that to sleep beneath its shade is fatal; and that the land-crabs found in the groves of manchineel become poisonous from feeding on its seeds. Although there is much exaggeration in these stories, no doubt exists of the deadly effects of manchineel juice when introduced into the system.

Mancinite. A brown silicate of zinc [SMITHSONITE] from Mancino, near Leghorn.

Mandamus (Lat. *we enjoin*). In Law, a prerogative writ, in the form of a command, issuing from the Court of King's Bench, directed to any person, corporation, or inferior court of judicature within the king's dominions, requiring them to perform various duties. It is grounded on the suggestion of a party injured by the acts or omissions of such persons or bodies; and lies, for instance, to compel the admission or restoration of a party applying to an office or franchise which has been illegally withheld, for the production of public papers, to compel the holding of courts, &c. The proceedings on mandamus have been remodelled by the Common Law Procedure Acts, 1852 & 1854, so as nearly to resemble those on an ordinary action.

Mandarin. The Portuguese term (from Port. mandar, Lat. mandare, *to command*) for a member of the official order of nobility in China. Mandarins are either civil or military: of the former there are nine classes, of the latter five. Although the mandarins are inferior in dignity to the higher class of nobility, whose dignity partakes of a personal character, they form the effective ministry and magistracy of the country. The Chinese equivalent of *mandarin* is *kouon*, which signifies literally *a r[illegible] character*.

Mandats (Fr.). A French gove[illegible] negotiable security, issued for a short time (under the Directory) after the withdrawal of ASSIGNATS [which see].

Mandelic Acid (Ger. mandel, *an almond*). A white crystalline acid obtained by the action of hydrochloric acid on bitter-almond oil. Its

chemical formula is $C_{16}H_7O_5 + H\,O$. It has also been called *Formobenzoilic acid*, inasmuch as it contains the elements of formic acid and hydruret of benzoyle.

Mandible (Lat. mandibula, *a jaw*). In Zoology, this term is applied to the lower jaw of, mammals, and to both jaws of birds (except by Illiger, who restricts its meaning to the lower jaw in this class also). In insects it is applied to the upper or anterior pair of jaws.

Mandibulates (Lat. mandibula). The name of a grand section of insects, including all those which preserve their organs of mastication in their last or perfect stage of metamorphosis.

Mandioc. The American name of a plant, otherwise called *Cassava*, which is cultivated within the tropics of America, for the sake of the fæcula contained in its stems. It is the *Manihot utilissima* of botanists, formerly called *Iatropha Manihot*. Tapioca is one of its products. In its raw state the plant is poisonous; but by torrefaction and washing the fæcula is rendered harmless. [MANIHOT.]

Mandragora (Gr. μανδραγόρας, corrupted into the French *main de gloire*, and the English *mandrake*). The name of a genus of *Solanaceæ*. *M. officinarum* is a beautiful autumn-blooming perennial, with wavy margined leaves and deep purple flowers. It has a thick fleshy root. The herb mentioned in Genesis xxx., which our translation renders mandrake, was probably some flower or root to which common belief attached value as a philter. The mandrake of modern as well as classical superstition is a herb supposed to have a resemblance to the shape of a man. Those who tear it from the ground are obliged to do so with peculiar ceremonials: shrieks and groans are heard to issue from it, which have the power of injuring the unwary person who hears them. Its favourite habitat was believed to be the ground under a gallows on which a criminal was hanging. When plucked, it was said to be useful in conjurations, for the transformation of men or beasts; and was also believed to enable the possessor to acquire riches at play, and to discover hidden treasures.

Mandrel (Fr. mandrin). In Mechanics, a revolving shank to which turners affix their work in a lathe; it also signifies the part of the anvil, or other tool, used by smiths to fashion the rough work upon.

Mandrill. A baboon. The name of the Catarrhine monkeys of the genus *Papio*, Cuv. They are the largest, most brutal, and ferocious of the baboons. The mandrill proper is the great blue-faced baboon of our menageries—*Simia Mormon* and *Maimon* of Linnæus. It is of a greyish brown, inclining to olive above, with the cheeks blue and furrowed. The nose in the adult male becomes red, and even inclines to a fine scarlet at the end. It is difficult, says Cuvier, to imagine a more hideous or extraordinary animal. The male attains the size of a man, and is a terror to the negroes of Guinea and the other parts of Africa, of which this species is a native.

Manes. The general name given by the Latins to the spirits of the dead. The word means 'the good ones,' and recurs in the name of Mana, an Italian goddess, and its opposite is found in the word *immanis*. They were commonly identified with the lares, and so received the name of Dii Manes. In the month of February, annually, all the Manes were propitiated in the Feralia or Parentalia during twelve days. The stones in the Roman burial-places, and their funereal urns, were generally inscribed with the letters D.M.S. (Dis Manibus Sacrum).

Manganese. This name is generally given to a black mineral, originally described, in the year 1774, by Scheele as a peculiar earth, afterwards shown by Gahn to be the oxide of a metallic substance which he called *magnesium*. This term, however, having been applied to the metallic base of magnesia, the word *manganese* has been adopted to designate the metal; and the ore above referred to has been called *black oxide*, or *peroxide of manganese*. The metal itself has a specific gravity of 8·013. It is grey, hard, brittle, and very difficult of fusion. The black oxide is largely employed as a source of oxygen, and is especially important from the use which is made of it in the decomposition of hydrochloric acid for the production of chlorine. Manganese has the atomic weight 28; and the black oxide, being a compound of 1 atom of manganese and 2 of oxygen, has the equivalent 44 (28 + 16). There is also a protoxide of manganese, composed of 28 metal + 8 oxygen, which is the basis of the salts of this metal. When hydrate or carbonate of potash, or nitre, are fused with peroxide of manganese in an open vessel, a dark-coloured compound is obtained, long known under the name of *chameleon mineral*, in consequence of its yielding in cold water a solution which is at first green, then blue, purple, red, brown, and ultimately deposits a brown powder, and becomes colourless. This substance contains *manganate of potash*. A compound of 1 atom of manganese and 3 of oxygen has been called *manganic acid*. In the pink solution, which is produced at once by the action of hot water, manganese exists in a higher state of oxidation, forming the *per-manganic acid*; in which 2 atoms of manganese are combined with 7 of oxygen. Both these compounds are very easy of decomposition, readily yielding oxygen to organic matters, and are used as deodorisers and disinfectants. Some of the protosalts of manganese are used in calico-printing as the source of brown colours, and occasionally as deoxidising agents. Manganese is sometimes present in steel.

Manganese Spar. [RHODONITE.]

Manganite. Grey oxide of manganese. The purest and most beautifully crystallised ore of manganese, of which it is a hydrated peroxide. It occurs in columnar crystals, which are striated vertically and often grouped in bundles; also fibrous and massive, or radiating, and granular.

Mange (Fr. démanger, *to itch*). An eruptive disease which attacks several domestic animals, especially the dog. It is said to resemble the itch, and, like that disease, to be produced by a minute species of acarus which burrows beneath the cuticle. It is stated that the fluid discharged from the eruption of mange, in horses and dogs, has produced the itch upon the human skin. It is produced by confinement, want of cleanliness, and bad food.

Manger. On Shipboard, the space near the hawse holes, bounded on the after side by a partition across the bows, called the *manger board*, to receive any water which may enter the hawse holes. This water, instead of being allowed to flood the deck, is forced to return through the scuppers.

Mango (mangos marum, in the Tamul language of India). The *Mangifera indica*, a very large fruit tree, inhabiting the tropical parts of Asia, throughout all which it is as extensively cultivated as the apple and pear are in Europe. Old specimens have been seen with a trunk from ten to fifteen feet in circumference. The fruit is something like a nectarine, but more compressed, longer, and more curved. It contains a large stone, covered with coarse fibres, which lose themselves in the succulent flesh. The wild and inferior varieties of this fruit taste so strongly of turpentine as to be wholly unfit for use by Europeans; but in the fine varieties this flavour is replaced by a rich sugary quality, which renders it very delicious. In this country the mango has rarely ripened its fruit; but it is commonly sold in a pickled state.

Mangold Wurzel or **Mangel Wurzel.** The root of the *Beta vulgaris macrorhiza*. It is cultivated for the food of cattle, and for its saccharine juice. [Beet.]

Mangonel (Ital. manganella, Gr. μάγγανον). An ancient engine of war, similar to the trebuchet. [Trebuchet.]

Mangosteen. The fruit of the *Garcinia Mangostana*, growing in Java and the Molucca Islands: it is of the size of an orange, and of a delicious flavour.

Mangrove (probably an abbreviation of *mangle* grove, the former being the Malay name). A tree inhabiting the shores of the tropical parts of the world in either hemisphere, and well known to navigators on account of the dense groves which it forms even down into the water itself. It belongs to the genus *Rhizophora* (its name being *Rhizophora Mangle*), and is principally remarkable for its seeds germinating before they leave the case in which they were generated on the branches. The young radicle grows downwards through the humid air till it reaches the mud, in which it fixes itself, and then the leaves and new stem unfold at the opposite end. The White Mangrove is *Laguncularia racemosa*, and the Black Mangrove *Avicennia tomentosa*.

Mania (Gr.). Madness. It is defined to be delirium, unattended by fever. The emotions are especially disordered in this form of insanity. Violent expressions of passions attend the disease when acute.

Manicheists. The followers of Manes, an Oriental heretic of the 3rd century, who, having been ordained a Christian presbyter, attempted to effect a combination between Christianity and the current philosophical systems of the East. He pursued herein the same course with the Valentinians, Basilidians, and many others, whose leading ideas may be denominated Gnostic. He maintained a dualism of principles governing the world, and a succession of dualisms generated from them, like the Gnostic æons. All things were effected by the combination or repulsion of the good and the bad; men had a double soul, good and evil; even their bodies were supposed to be formed the upper half by God, the lower by the Devil. The Old Testament was referred to the inspiration of the evil principle, the New to that of the good. In the latter, Manes proposed many alterations, and maintained also the authenticity of various apocryphal scriptures. A great part of his system related to cosmogony and psychology. Like most other Oriental systems, the Manichean heresy was celebrated alike for the austerities which it enjoined, and for the scandalous excesses which were attributed to its most zealous votaries. The charge of Manicheism was frequently brought against the early reforming sects, such as the Albigenses, Waldenses, Picards, &c. (Beausobre, *Hist. Critique de Manichée et du Manichéisme*, Amst. 1734; Gieseler, vol. i. 150 (transl.), ii. 151, iii. 340; Milman, *Hist. of Christianity* ii. 322.)

Manifesto. In Politics, a declaration of motives publicly issued by a belligerent state, or by a general acting with full powers, previously to the commencement of hostilities. They are in the form of letters, with a superscription or heading addressed to the public in general, and signed with the name of the sovereign who sends them forth. The usage of issuing manifestoes is said to date so far back as the fourteenth century. The term is probably derived from the Latin words *manifestum est*, with which such documents usually commenced.

Manihot (its native name). A genus of *Euphorbiaceæ* cultivated in tropical America for the Mandioc or Cassava root furnished by one of its species, *M. utilissima*. They are shrubby plants, with palmatifid leaves, and fleshy roots, from which the Cassava is prepared. [Mandioc.]

Manipulation. In Chemistry, this term embraces the manual and mechanical operations of the laboratory; and in the delicate details of analysis, as well as in the exhibition of class experiments, great skill and practice in manipulation are required. The processes of weighing, measuring, filtering, distilling, precipitating, dissolving, using the blowpipe, &c. all come within the meaning of manipulation.

Manipulus (Lat.). In Roman Military Antiquities, a subdivision of the cohort: so called from the handful of grass, straw, &c. which formed its original standard. A maniple of triarii consisted of 60 men, one of hastati and

principes of 120, when the number of the legion was 300. [LEGION.]

Manis. The name of a genus of Edentate Mammals, singularly characterised by being covered with large, strong, imbricated horny scales, like the Lacertine reptiles, and hence commonly called scaly lizards, and figuring in old zoological works among that class of animals. The manises, or pangolins, are, however, true warm-blooded mammals, and rank in the system of Cuvier among the Edentate order; of which they may be regarded as typical forms, being destitute of teeth, and provided with a tongue of extraordinary length, with associated glands for preparing an abundance of adhesive mucus. By this organisation they are peculiarly adapted to prey on ants, termites, &c.; and certain of their claws are extraordinarily developed, to enable them to break through the walls of the habitations of these social insects. The manises are confined to the warmest regions of Asia and Africa, where they play a corresponding part with that assigned to the true ant-eaters (*Myrmecophaga*) in South America.

Manitrunk. In Entomology, a term given to the anterior segment of the trunk, in which the head inosculates, or on which it turns.

Manna (the Hebrew form of this word is *man*; some hold that the Jews adopted the Arabic name, while others regard it as an Egyptian word). What we now call *manna* is a saccharine substance which exudes from the bark of various species of Ash, chiefly *Ornus rotundifolia* and *europæa*, species formerly referred to *Fraxinus*, natives of the south of Europe, especially Sicily and Calabria. Manna is used in medicine as a mild aperient. It differs remarkably from common sugar in not being susceptible of vinous fermentation; so that, if mixed with common sugar and yeast, and subjected to the process of fermentation, the sugar becomes converted into carbonic acid and alcohol, but the manna remains unaltered in the liquor. When manna is dissolved in boiling alcohol, the solution, as it cools, deposits it in flaky and acicular crystals, often arranged in concentric groups. Manna, thus purified, has been chemically designated by the term *mannite.* Mannite is found in variable quantities in a great variety of plants, and is a product of the vinous fermentation of sugar. The composition of mannite is represented by $C_8H_7O_6$, or $(C_8H_5O_4+2HO)$.

Manna Croup. The prepared seeds of *Glycerin fluitans*; also a granular preparation of wheat deprived of bran, used as an article of food for children and invalids.

Mannite. [MANNA.]

Manometer or **Manoscope** (Gr. μανός, *rare*, and μέτρον, *a measure*, or σκοπέω, *I view*). An instrument for measuring the *density* of the air, or rather its *elastic force*, to which the density is proportional. [PNEUMATICS.]

Manor (Old Fr. manoir, from Lat. maneo, *I abide*). On the introduction of the feudal system into England, and the consequent establishment of the principle that every person, save the king, was dependent on a superior, the whole country was parcelled out into lordships or manors. These divisions have generally, but not always, the same boundaries as the parish, single parishes having sometimes two or more manors in them. All manors contained, under the lord, a number of freeholders owing suit and service, a number of nativi or villeins owing suit and labour, and a few peasants called *coterales*, who occupied huts with some small curtilage or garden annexed.

The manor court was an invariable accompaniment of the manorial system, and the records of these courts formed the evidence for which the customs of the manor were maintained. These customs present an infinite variety, though in consequence of the general enfranchisement of copyholds, the modern representative of the villein or base tenure, many customs have become obsolete. The manor court in mediæval times was the chief police machinery of the age. It took cognisance of breaches of the peace, and where it had the high jurisdiction, inflicted penalties for felony. It had a coordinate jurisdiction with the coroner over fraudulent dealers, and exacted fines for violations of the assize of bread and beer. The process was very simple and effective. The lord of the manor presided by his steward, and a jury variable in number was elected. Sometimes the jury chose the seneschal or steward. The first business of the jury was to enroll adults, if any appeared, in the decenna, or tything, a small fine being levied on registration. This regulation was part of the old view of frankpledge. Then they appointed aletasters, who licensed common brewers to broach such casks as the tasters declared to be equal to the strength or goodness designated by the assize. Heavy fines were inflicted on any breach of this regulation. Similarly they who sold bread contrary to the assize were mulcted.

The jury then presented all offenders against the peace. The commonest charges, as might be expected, were those of injurious language and assault. The culprit was said to be placed at the mercy of the court, and a small fine was levied for the offence. When the offence was committed by a married woman, the husband was mulcted, and pledges were exacted for payment of the fine.

The proceeds of all fines were paid to the lord. As the steward could inflict no penalty except on the presentment of the jury, a check was put on extortion by the feudal superior, and it was the plain interest of the lord to levy moderate fines on culprits. As the penalties became the property of the lord, the tenants could not or would not make the sentences of the court a means for individual prosecution, or, at least, of private advantage; while the authority of the court was habitually invoked in order to save the tenants from dishonest practices, or turbulent and violent acts. No manor, however, it appears, could take cognisance of any plea involving a

tenant's right to his lands, except, of course, in breaches of fealty. These pleas were reserved to the county court, or (when this court became obsolete) to the courts at Westminster Hall or the justices in eyre.

Manropes. On Shipboard, the small ropes used to assist in passing up and down gangways, hatchways, &c.

Mansard Roof. In Architecture, this word is applied to a curb roof sufficiently lofty to admit of an attic being lodged in it. The Mansard roofs are so named after their inventor, who introduced them in consequence of a municipal law fixing the height at which the front walls of houses might be built in Paris. They are characteristic of the architecture of the period of Louis XIV.

Manse (Low Lat. mansus, mansum, *a residence*). The term used in the northern provinces of England and in Scotland to express a parsonage house.

Manslaughter. In English Criminal Law, this term is defined a 'felonious killing without malice, before the blood has time to cool,' including, in practice, both killing under the influence of sudden passion, and also killing by careless accident or negligence. It is thus distinguished from murder on the one hand, and from excusable or justifiable homicide on the other. The offence is felony, and the punishment varies from penal servitude for life down to imprisonment or fine of the slightest amount, according to the several circumstances of what is of necessity a very various class of actions. [HOMICIDE; MURDER.]

Mantelet. [MANTLET.]

Mantis (Gr. *a prophet*; applied by Theocritus, *Idyl.* x. 18, to the cicada). A Linnæan genus of Orthopterous insects, characterised by having the head exposed, and the body narrow and elongated; the palpi short, and terminating in a point; the ligula quadrifid; the tarsi five-jointed; and the wings simply plaited longitudinally, and not ray-wise, like a fan. The true mantises—sometimes called *praying insects*, on account of the position of the anterior pair of legs, which differ from the rest—are found only in tropical and temperate climates. They are diurnal, and remain almost stationary on plants and trees; frequently resembling, in a remarkable degree, their leaves and branches in both the form and colour of the wings and body, and thus they deceive the smaller insects on which they prey. Their eggs are usually enclosed in a capsule formed of some glutinous substance, which hardens by exposure to the air, and is divided internally into several cells. It is curious to trace the correspondence with the vegetable kingdom already noticed in the wings and body continued into the form of the egg-capsules, which in many species closely resemble a seed receptacle of a plant, presenting regularly disposed ridges and angles, or even being bristled with little spines. The female attaches it by an adhesive secretion generally to the stem of a plant.

A second group of mantises, characterised by having the anterior legs like the following ones, now form a distinct subgenus, *Spectrum*, and are generally called *spectre insects*. They feed exclusively on vegetables, of which they singularly resemble the dried twigs. The progress of entomology has required further subdivisions of both the above groups.

Mantissa (Lat. *addition* or *overweight*). The decimal part of a logarithm. In Briggs' system the mantissa remains the same, and always positive, so long as the number has the same significant digits. On this account mantissæ alone are registered in tables of common logarithms. They differ from the true logarithms only by positive or negative integers, called *characteristics*, which can be easily supplied. [LOGARITHMS.]

Mantle (Lat. mantellum, Fr. manteau). In Architecture, the piece lying horizontally across from one jamb of a chimney to the other.

MANTLE. In Malacology, the external fold of the skin of the molluscs.

Mantlet (Fr. mantelet). A movable shield used as a protection to the sappers in carrying a sap towards a besieged place, or to protect the gunners at an embrasure. Mantlets are made proof against the fire of small arms.

Manual (Lat. manualis, *held in the hand*). A name originally applied to the Roman Catholic service book, from its convenient size (being such as might be carried in the hand); but it now signifies any work used chiefly for the purpose of reference.

Manufacture (Lat. manufactus, *made by hand*). In Political Economy, a term employed to denote the processes by which materials, already produced by labour, are made to undergo some change or modification, and thereupon become available or more convenient for human use. Some of the products of human labour, as coal, are immediately useful; but by far the greater amount of such materials as are intended to supply human wants or demands, require beyond the labour needed to produce or collect them a further manipulation, in order that they may serve the ultimate purpose for which they were originally sought. Thus, after the labour of the husbandman has been devoted to the production of corn, the labour of the miller and baker are required, that the corn be ground, dressed, and made into bread. So with the process of mining. The miner gathers the ores, or the crude metals of which he is in search, in order that the raw material may be handed over to the industry of another class of workmen, who fashion the produce of this ruder labour into the various implements which the necessities of civilised societies require, or comfort and elegance demand. In common language, this secondary labour is called *manufacture*, not indeed with absolute correctness, for the agriculturist and the miner are effectively manufacturers as well as the miller, the baker, the iron-master and the smith, but the usage of language gives sufficient distinctness to the sense in which the term before us is employed.

The province of manufacture, therefore, is to shape or modify materials with a view to the developement of those powers or forces which they possess, and which are necessary, useful, or convenient to mankind. Some materials are produced by chemical changes in the constitution of objects, and the change necessary for their being made available for human use can be effected immediately by human labour; in some the change is brought about by natural chemistry, and human labour is employed indirectly towards their production. For instance, iron can be reduced from its ores by processes more or less complex, but an organic substance like wheat, wool, or meat, can be produced by natural processes only, chemical skill being wholly incompetent to synthesize the elements into which these products can be readily analysed, and so to produce them indefinitely and at pleasure. In these cases, all that human labour can effect is to select such localities as are fit, or most fit, for production, and to stimulate the natural process by such aids as science or experience have discovered. When the material has been procured by one or the other of these methods, it needs, as has been said, a further manipulation to render it useful. This process of manufacture is carried on, and the labour exerted on it is diminished, by the application of those principles by which progressive wealth is conditioned; those, namely, of the division of labour, and the economy of forces.

By the division of labour is meant that continual distribution of the various mechanical acts which contribute to a single result among an increasing number of agents or labourers. In order that a material may be rendered suitable for immediate utility or consumption, a great number of separate acts must needs be performed upon it. When the simplest object of common use is examined, it will be found that it is the product of a very large amount of distinct muscular efforts. A common pin, for instance, is a pointed piece of brass wire, covered with a thin coating of tin, and furnished with a head. Familiar as such an instrument is, and obvious as is its construction, it needs, in order to be produced, perhaps some fifty different acts of labour. The same remark would apply in still greater measure to a watch, or, as we are told, to a playing card. It will, however, be manifest, that if one person had to perform all these acts, much time would be lost in turning from one act to another; that the dexterity with which one habitual act is performed will be much greater than could be acquired if the same man had to perform fifty or a hundred separate acts; and that, as some of those acts are more difficult than others, there would, if the same person did all, be a great loss in the charge of production, because the lowest labour would be paid at the same rate as the highest. Hence, as every producer wishes to produce at the least possible cost, or charge, or labour to himself, and the same motive applies to the employer of a hundred or a thousand workmen as to an individual labourer, there is always an increasing tendency towards splitting up complex operations into as large a number of separate occupations as possible, in order that the greatest results may be achieved with the least possible labour or loss, since all superfluous labour is a waste of force, and an economical loss. This collection, however, of separate labourers for the purpose of producing a joint or common result can be effected only by the employment of large capital in manufacture, and consequently by such arrangements as secure to a moral certainty a profit to the person who ventures on such an undertaking.

The same disposition which underlies all economical progress, the wish, namely, to achieve the largest possible results with the least possible expenditure, leads to that economy of forces which is the aim of manufacturing industry. It will be manifest that all value is achieved by labour exercised upon materials, and their qualities, in answer to an effectual demand for the produce. But although muscular and nervous labour, that is, work of the hand and brain, are needed to set those forces in motion and direct them to the required end, still there are natural forces which man may appropriate, and by which he can arrive at results far more stupendous than could be reached by the labour of his single arm, or by any human power, however unsparingly combined or applied. These supplementary forces are not only more effective, but they are far cheaper. The substitution of animal for human labour is a direct economy, the power exercised by a horse being far less expensive than the same amount of power supplied by a man. Similarly, and indeed in even greater measure, the force of running water is far more cheaply applied than animal labour can be; and in a fuller sense still, the late discovered power of steam is generally much less costly, and always much more effectual, than the agency of the natural motion of water and air. Hence it is that these powers of nature have been, on discovery, rendered available for human purposes; and hence, also, the energies of systematic discovery and careful adaptation are constantly called into activity by the same disposition to economise cost, and to diminish direct human labour. It is by such means that the progress of modern society has been so rapid; and the fruits of research and reason are, it may be fairly predicted, made so secure to the human race, that a decline into barbarism, and a loss of civilisation, with a retrogression such as that which ensued on the downfall of the Western Empire, may be pronounced to be theoretically impossible. Modern civilisation is so fenced about by the adaptation of natural forces, that it is not conceivable that any barbaric vigour should be able at any time to force its barriers and rifle it of its superiority.

It is only in modern times that the inductions of physical science have been rendered available for the economical progress of society. And the reason appears to lie plainly in the

fact that modern societies alone have freed themselves from the cancer of slavery. In ancient communities the growth of mechanical skill, except to a scanty extent in the arts of war, was checked by the absence of the motive referred to above. There is no impulse towards economising labour and supplementing the physical energies of man by the appropriation of natural forces, when labour is compulsory, and its fruits are denied to the persons who afford it. No nation, it may be broadly laid down, ever made any notable progress in those arts which are called generally manufactures, in which slavery was encouraged, maintained, or even permitted. The existence of this social anomaly is an absolute bar to all economical advancement. Military science may indeed achieve some victories over natural forces, and appropriate some of those supplementary powers, but it does so only partially, and would not at all were it not that the duty of public defence being confined for obvious reasons to the free citizens, the impulse to the economy of labour in this direction does to some extent exist. But it has always been found that the progress even in this direction is scanty, states in which slavery prevails having been almost always led into the employment of mercenary troops, and with this practice necessarily losing the motive which, as has been said, is dominant in the progress of invention and adaptation, that is, economy of labour, of time, and of cost.

When a nation has no manufactures beyond those which are absolutely necessary for the supply of home wants, the *stationary* condition is soon reached. It seldom happens, however, that any country is so situated as to be absolutely debarred from any but a purely agricultural industry, though it may very well happen that communities may be too eager to enter into competition with foreign markets, or to preclude supplies from foreign markets, either by a bounty on their own produce, or by protection to the home manufacturer. There are, it may be safely asserted, no natural circumstances under which a protective policy entered on with a view to originate or sustain a domestic manufacture, is not followed by loss and inconvenience to the general interests of the community which adopts the restriction or the stimulant.

It is too often the case that prejudiced parties either ignorantly or maliciously argue a diversity of interest between one branch of industry, as the agricultural, and another, the manufacturing. The landlord as letting the use of the soil, the farmer as selling its produce, are as much interested, though indirectly, in the success of manufactures, as the manufacturer himself. For, in the first place, the success of any branch of industry implies a corresponding increase of purchasers and a corresponding power of purchase; and, in the next, the same intelligence which adapts mechanical forces to purely manufacturing purposes has led to those discoveries which have revolutionised agriculture, and increased in modern times so notably the rate of production from the soil. A short-sighted policy sometimes sees profit in dear times, or under a temporary scarcity; but the farmer's trade is not in one commodity, but in many, and an increase in the price of one or two among the articles which he produces may be, and is, often compensated by a great decline in the demand for other articles. Free trade in corn has benefited the agriculturist and the landowner, because although one kind of produce has been cheapened, a great rise has occurred in the price of other agricultural products, and this rise, as is well known, has involved a great increase in rents. In short, any attempt to argue about the relative significance of different kinds of labour in the great staples of national industry, is equivalent to discussing which of the two numbers 5 or 4 contribute most to the product 20.

Some manufactures must always be carried on in every country, i. e. those of which the use is universal and the value low, and in which the cost of carriage is great and disproportionate to the intrinsic value of the article. Every community, therefore, carries on an industry in the commoner kinds of pottery, in ordinary agricultural implements, and in some of the coarser kinds of clothing. But when the circumstances of any particular community are favourable to a branch of industry, the produce of such an industry will sooner or later become the object of labour in such a community, and can never be advantageously stimulated by external aid or exceptional support.

Certain moral conditions must be fulfilled before manufactures can be practised advantageously, or indeed at all. We have already adverted to one, the condition, namely, of personal freedom in the labourer, and the right to appropriate whatever part of the general wealth of society the demand for his labour enables him to obtain. Freedom, indeed, is as essential in political economy as it is in morals, and the foundations of either science are equally sapped when the freedom of the agent is invaded.

Again, in order that manufactures may flourish, security must be afforded to the producer. It is vain to expect economical progress when property is insecure and governments are rapacious and negligent. The ravages of war are no doubt eminently destructive; but no foreign war, and no loss from public enemies, can equal the mischievous effects induced by a profligate, corrupt, or extortionate administration. Asia Minor and Syria, with the region lying between the two great rivers of Western Asia, are now among the most impoverished regions of the earth, though full of the relics of an ancient but imperfect civilisation, and through their present desolation giving abundant proofs of a vast and prosperous population in bygone times. The sole cause of the change is to be found in the character of the governments by which these regions have been so long afflicted. It is only

in degree that all unwise or partial legislation fails to produce similar effects. The social system of France, and the iniquitous method of taxation which preceded the Revolution, entirely prevented the material progress of that country.

Again, in order that progress be made in manufacturing industry, it is essential that the commercial morality of the trading or producing class should be unimpeachable and exact. It has not rarely happened that a foreign trade has been lost by the shortsighted dishonesty of manufacturers, and that the efforts made to extend trade have been neutralised, from a well-founded impression that the manufacturer or merchant is unsafe or fraudulent. Even if a purchaser were always competent to pronounce at sight on the soundness of wares, it is inconvenient to be compelled to do so, and the adoption on the part of the producer of the maxim *Caveat emptor*, will be found to be rather cunning than wise, and ultimately not even cunning.

It is also very necessary that the relations of labour and capital should be satisfactorily balanced. Both must be sufficiently abundant in order that manufactures should exist at all, for labour is to be set in motion by capital, and capital will not be accumulated, or if accumulated will be wasted, unless labour in sufficient quantity be present for its employment. Hence any hindrance to the free circulation of labour or capital is a bar to the prosperous developement of manufacture; and by parity of reasoning, distrust on the part of labourer or capitalist, or exaction on the part of the former, will tend to derange these relations, and induce an insecurity in the continuance of the industry. It is said, and probably with justice, that much of the local distress in certain manufacturing towns is due to the habit of irrational and unwarranted strikes. It is certain that every capitalist who engages in any manufacturing avocation, will take into his profit and loss account the risk of a compulsory cessation of the beneficial employment of his capital, and if the evil is perpetual, may cease to employ capital in the direction which exposes him to the danger. That an extension of primary education among the mass of the working classes is a powerful contribution to the growth of mechanical skill and manufacturing industry, will hardly be denied. The quickness with which an educated person can adapt himself to circumstances as compared with one who is deficiently taught, has been often commented on. But it may be urged with great force, that the value of such an education lies more in the aid which it gives to the possessor in understanding and improving his own condition, than in the special aptitude which he derives for a vocation the operations of which, by the effect of the division of labour, become more and more definite. The moral value of education cannot be overrated, and it is to the spread of this education that we must trust for the refutation of those erroneous views about the relations of labour and capital which tend so much to interfere with the industrial energies of the community. And it has been found that educated workmen are not so valuable for the increase of their mechanical skill, as for the fact that reliance can be placed on their character, and confidence felt in their self-respect.

It has been stated, that there are few countries in which manufactures of some kind or other cannot be carried on. In order to utilise natural forces, and especially that force which has in effect completely changed the process of human industry, the power, namely, of steam, fuel must be cheap and accessible. Coal, the chief agent in the more important manufactures, has a very wide geographical range (few countries, except those in which the geology is almost entirely of primitive rocks, failing to supply it in a greater or less degree), and the list of coal-bearing regions becomes constantly larger in consequence of geological research. Even, however, in those countries where coal is deficient or absent, there are generally abundant metalliferous veins, and therefore a natural material for human industry. But it is also found that climate has much to do with particular branches of manufacture. It may be doubted whether machinery such as we are familiar with, could be worked continuously or safely in tropical countries. Where the temperature is high, it appears that the gear of delicate machinery gets rapidly out of order; and it is by the exceeding delicacy and precision of modern machinery that the greatest triumphs of manufacturing art have been achieved. Even, however, if machinery equally available for manufacturing purposes could be supplied for regions in which the mean temperature is high, there still remains the difficulty of supplying and accommodating labour in sufficient abundance and efficiency.

It has been said that silk dyeing can be carried on only under exceptional atmospheric conditions, and that no skill in manipulation, and no chemical art practised by English silk dyers, will enable them to compete successfully with the manufacturers of the south of France where the clearness of the atmosphere and the brightness of the sun give a gloss and finish to goods superior to anything which can be produced elsewhere. Similarly, the atmospheric conditions of this country, and [illegible]ly the general humidity of the region in which the great cotton and woollen manufactures of England are carried on, enable the producer to spin a finer and tougher yarn than could be made in any other country. Spinners from the United States have been astonished at the excellence of the thread manufactured by their English rivals, and, despite all possible invention and adaptation, despair of equalling the perfection to which this art is brought. The secret, they find, lies in the climate; and it is asserted, that even if the supply of coal should fail, and it became necessary for this country to import fuel, England would still be the foremost coun-

try in the production of finer cotton and woollen goods. The time is probably far distant when the coal of this country will show signs of exhaustion, and by that time it is very likely that the cost of shipbuilding and freight will be so far reduced that coal may be imported at a comparatively trifling charge from the vast fields of Eastern America.

There is nothing, lastly, which appears at present to justify any alarm about the permanence of the manufacturing eminence of this country. The physical conditions which have induced the mercantile prosperity of the United Kingdom are generally permanent; and even those about the duration of which some alarm has been expressed, are at present so extensive as to make the contingencies contemplated exceedingly remote. Nor can it be doubted, that many changes are going on in the relations of capital and labour, from whose present antagonism some rational fear may be felt; but this conflict will ultimately tend to a more thorough harmony between jarring but mutual interests. It seems likely that the co-operative principle will, not long hence, occupy a very important position in manufacturing industry, and that a natural solution will be given to the grave questions which have latterly assumed so much prominence, by the union of rival interests in the same individuals. In such a case, if common integrity pervade these new establishments, there seems little doubt that greater effectiveness will be given to labour, greater elasticity to capital, and greater economy in production. (Babbage *On the Economy of Machinery and Manufactures.*) [TRADES UNIONS; LABOUR.]

Manumission or **Enfranchisement** (Lat. manumissio). The grant of liberty to a slave. Ancient charters containing such grants were frequently termed *chartæ ingenuitatis.* (See a law of William the Conqueror, *Lamb. Archai.* 126.) The term *manumission* is derived from a practice adopted by the ancient Romans in enfranchising their slaves. The master seized the hand of the slave, and dismissed him with the words, 'Hunc hominem liberum esse volo.' Among the Romans there were two classes of manumission, called perfect and imperfect; the former of which was effected in three different ways. The enfranchisement was perfect—1. Per censum; by which the name of the slave was, at the master's request, placed in the register of free citizens. 2. Per vindictam; when the slave was led before the prætor, and, the master having demanded his liberty, that magistrate laid the vindicta (or rod of office) on his head, with the words, 'Aio te liberum esse more quiritium.' 3. Per testamentum; by will. It was imperfect when the slave was enfranchised at private entertainments, or by letter. [CLIENT.]

Manures (Fr. manœuvrer = Lat. manu operare, *to work with the hand*—a derivation which seems to recognise the fertilising influence of mere tillage operations on the soil, as well as of direct additions of fertilising matters). Manures are substances added to the soil, with a view of accelerating vegetation, and increasing the production of the crops. Animal, vegetable, and mineral substances are used for this purpose. Decomposing animal matter of any kind forms one of the most powerful manures, and in many instances hastens the decay and decomposition of inert vegetable matters mixed with it; as in the mixture of dung and straw which forms the common offal of stables. All animal excrements are also powerful manures, and, when duly applied to the soil, soon exhibit their influence by the luxuriance of the crop. Manures act simply as supplying the building material which vegetable increase requires. All plants needing certain substances in certain quantities for their growth, the body which is present in the soil in minimo rules the crop. It is generally the case that nitrogenous compounds and phosphoric acid—more rarely potash and lime—are the substances thus present in minimo, an addition of which, whether in animal or vegetable or mineral compounds, to the soil is required in order to produce an abundant growth.

In all cases where animal manures are used, care should be taken that they are brought into action upon the soil as soon as they begin to decompose, or as soon as possible afterwards, and not suffered to rot, and exhale their best constituent parts whilst lying in the farmyard. The drainings and to a less extent the exhalations of a common dung-heap contain its most effective ingredients; and these are often suffered to go to waste, or to contaminate the air and collect in pools of filth. The fresh and the old manures of this description are known to farmers under the terms *long* and *short* dung: the advantages and economy of the former, when properly applied, cannot be doubted. Those animal manures which are slow of decomposition are most durable, and the more soluble substances are the more rapid in their operation. Of the former, one of the best is ground bones, which supply phosphorus to the soil and the crop. Of the latter, dissolved bones or super-phosphate of lime may be named as quick and efficient in action on those crops which require much phosphorus during their growth. Vegetable manures are often very effective, especially in the case of ploughing in a green crop; and inert vegetable substances may be rendered active by mixture with those which easily putrefy, or with animal matter. Mineral manures act not only by the direct addition of the ingredients needed for the food of plants, but also in some cases by their causticity, as is the case with quicklime, by which they decompose most organic bodies, such as roots, fibres, &c., and render them soluble and nutritious to the growing crop. They are also useful by altering the texture of the soil. Thus, sand may be called a manure for clayey lands, and clay and loam for those that are sandy. Upon the same principle, stiff soils [illegible] improved by paring and burning.

In fact, it is only as supplying what is strictly speaking *mineral* food to plants that manures of all kinds tend to promote vegetable growth. Animal and vegetable manures do not enter plants as such, or as solutions of organic matter. They must be decomposed into their original mineral elements, and take the form of carbonic acid, ammonia, and the various mineral salts, before they can enter plants or promote their growth.

MANURES, ARTIFICIAL. The artificial manufacture of manure has arisen out of the inability of the guano trade to supply the demand for imported fertilisers which its own success had created. Since 1841, when 2,881 tons of Peruvian guano were brought into Liverpool, and when its wonderful powers as a manure were first realised upon a sufficiently large scale to produce conviction in the minds of farmers, there has been almost everywhere a demand for the means of thus adding artificially to the fertility of the land. But the supply of guano, far from being able to meet this increasing demand, has been falling off. The average receipts for many years up to 1858 had been 250,000 to 300,000 tons a year. Since then the average supply has not exceeded 150,000 tons a year. Owing to this unsatisfied demand, there has been a very large manufacture of fertilisers which take the place of guano. Bonedust and mineral phosphates of various kinds, rendered soluble by the addition of one-third their weight of sulphuric acid, nitrate of soda, and sulphate of ammonia, are the principal ingredients of which these artificial manures are made. It is now almost the general practice to use two or three cwts. per acre of the soluble phosphate, or so-called superphosphate of lime, as a preparation for the turnip crop; nor is it unusual to apply one cwt. or more per acre of nitrate of soda as a top dressing for the wheat crop. The rule is to apply the nitrogenous manures to cereal and other grasses, phosphatic manures to turnips, and alkaline and calcareous manures to leguminous plants, as beans, peas, and clovers.

Manuscripts (Lat. manu scriptus, *written by the hand*). Literally, writings of any kind, whether on paper or any other material, in contradistinction to such as are printed. Books were generally written upon vellum, after the use of papyrus had become obsolete, until the general introduction of paper made from rags, about the fifteenth century after Christ; and the finest and whitest vellum is generally indicative of great age in a manuscript. The dearness of this material gave rise to the practice of using old manuscript books on which the writing had been erased [PALIMPSEST], and also to that of abbreviations. These were carried to excess in the twelfth century, and from that time down to a period subsequent to the invention of printing, they were still in common use: in Greek printing they were usual until within the last fifty years. Of Latin MSS. those prior to the reign of Charlemagne (A. D. 800) are considered ancient. Manuscripts of the early classical age were written on sheets rolled together. *Illuminated manuscripts* are such as are embellished with ornaments, drawings, emblematical figures, &c. illustrative of the text. This practice was introduced at a very early period; for we find the works of Varro, Pomponius Atticus, and others adorned by illuminations. But it was chiefly employed in the office-books of the early Christian church. The colours most employed for this purpose were gold and azure. Illuminations were in a high state of perfection between the fifth and tenth centuries; after which they seem to have partaken of the barbarism of the middle ages, which threw their chilling influence over every form of art. On the revival of the arts in the fifteenth and sixteenth centuries, many excellent performances were produced; but the art did not take root, and among the last specimens of illumination executed in this country was Cardinal Wolsey's *Lectionary*, at Christ Church, Oxford. [CODEX; DIPLOMATICS; PALÆOGRAPHY.]

Map (Lat. mappa, *a cloth*). A delineation of some portion of the surface of the sphere (terrestrial or celestial) on a plane. Terrestrial maps are *geographic* or *hydrographic*, as they denote severally a portion of the land or of the sea; the latter, however, are usually called *charts*. [CHART.] A map representing a small extent of country is called a *topographical map*.

Terrestrial Maps.—The object of a terrestrial map is to exhibit the boundaries of countries and the relative positions of their several parts. A perfect representation of a country should present all its parts, not only in their true relative positions, but also in their just proportions. This may be accurately done on a globe; but as the earth's surface is spherical, it is impossible to represent any considerable portion of it on a plane so that the distances of places shall retain the same proportions which they have on the sphere, and geographers have accordingly had recourse to various methods of delineation, all of which have their peculiar advantages in particular cases.

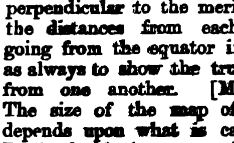
One method is to represent the points and lines of the sphere according to the rules of perspective, or as they would appear to the eye, having some assigned position relatively to the sphere and the plane of representation. This method gives rise to the different modes of *projecting* the sphere, of which the three principal are the orthographic, the stereographic, and the central. The method of projection answers very well when the surface to be represented is small, and the eye is placed perpendicularly over it; but when it embraces a considerable portion of the sphere, the parts near the extremities of the map are much distorted. [PROJECTION.]

A second method is to suppose the surface to be represented to be a portion of the surface of a cone, whose vertex is somewhere in the polar axis produced, and which either touches

the sphere at the middle latitude of the surface to be represented, or falls within the sphere at the middle latitude, and without it at the extreme parallels. The conical surface is then supposed to be developed on a plane (which may be done); whence this method is called the *method of developement.* Of this method there are various modifications: as that of Murdoch, who supposes the side of the cone to be parallel to the tangent of the meridian at the middle latitude, but to penetrate the surface of the sphere between the middle latitude and the extremities of the projected arc; that of De Lisle, who assumed the cone such as to intersect the sphere in the two parallels equally distant from the extreme and middle latitudes; that of Euler, who placed the apex of the cone at a determinate distance beyond the pole.

A third method is to lay down the points on the map according to some assumed mathematical law, the condition to be fulfilled being that the parts of the spherical surface to be represented, and their representations on the map, shall be similar in their small elements. Of such methods the best known is *Mercator's Chart* (which, however, may be produced also by developement), in which the meridians are equidistant parallel straight lines, and the parallels of latitude are also straight lines perpendicular to the meridians; but of which the distances from each other increase in going from the equator in such a proportion as always to show the true bearings of places from one another. [MERCATOR'S CHART.] The size of the map of any given region depends upon what is called its scale. In England this is expressed by the number of miles represented by one inch of the map. Thus, our Ordnance maps are six inches and one inch to a mile respectively. On the Continent, the ratio of the map to the actual area is taken, and the scale is represented by a fraction, as $\frac{1}{1,000,000}$, $\frac{1}{58,000,000}$, &c.

Celestial Maps.—For the construction of his maps of the stars, the astronomer Flamsteed adopted the following method: All the parallels on the sphere are represented by straight lines, and likewise one of the meridians; namely, that which passes through the middle of the map, as in the annexed diagram. The parallels which are all perpendicular to this meridian have the same relative lengths as on the sphere,



and consequently the degrees of longitude are represented in their just proportions; that is, are proportional to the cosine of the latitude. If, therefore, the parallels be each divided into the same number of equal parts, a curve line drawn through the points of division will represent the meridians. By this method any distance in the direction of the parallels is equal to the corresponding distance on the sphere; but it is evident that the map is much distorted towards the extremities, in consequence of the oblique directions of the meridians. Flamsteed's method is sometimes used in geography for representing countries which lie on both sides of the equator, in which case the distortion is less. A modification of it, which consists in substituting arcs of circles for the curved lines representing the meridians, whereby their obliquity is diminished, is extensively employed in the construction of maps.

For details respecting the general construction of maps, we refer the reader to the work of Mr. Jamieson on the subject; Malte Brun's *Geography*; Malte Brun's and Balbi's *Systems of Geography Abridged*; Murray's *Encyclopædia of Geography*; De Morgan's *Explanation of the Gnomonic Projection of the Sphere*; and particularly the *Traitè de Topographie d'Arpentage et de Nivellement* of Puissant.

Maple. The popular name of the *Acer* family. The Common Maple is *Acer campestre*; the Norway Maple is *Acer platanoides*; the Sugar Maple, *Acer saccharinum*; and many other species are cultivated as ornamental trees. [ACER.]

Maranatha (Syr.). A form of anathematising among the Jews, which was viewed as a tremendous denunciation. (1 Cor. xvi. 22.) It signifies 'the Lord will come;' i.e. to take vengeance.

Maranta (after B. Maranti, a Venetian physician and botanist). The genus which furnishes the true Arrowroot of commerce. The species are natives of tropical America, but are cultivated for the sake of their starch-yielding tubers in both the East and West Indies and tropical Africa. *M. arundinacea* especially, and also *M. nobilis* and *M. Allouya*, are thus grown in the West Indies; and both these and *M. ramosissima* in the East Indies. The fleshy jointed scaly tubers are reduced to pulp with water; the liquor is then strained, and the fecula allowed to settle; then again washed, and dried. The arrowroot thus obtained is a pure and nutritious starch. Other kinds of arrowroot are furnished by species of *Canna*, *Tacca*, *Curcuma*, *Manihot*, and *Arum*.

Marantaceæ (Maranta, one of the genera). The natural order of Endogenous plants, from which the most genuine kind of arrowroot is prepared. This substance is the starch contained in the tubers of *Maranta arundinacea*, and some other species, and of certain kinds of *Canna*. The *Marantaceæ* are very nearly the same as the *Zingiberaceæ*, from which they differ in the flowers being more irregular, and the anther having but one lobe instead of two.

Maraschino. [LIQUEURS.]

Marasmus (Gr. μαρασμός, from μαραίνω, *I waste away*). Emaciation; atrophy.

Maravedi. A Spanish coin of Moorish origin. At first it was made of gold, and Le Blanc states that in 1220 it was worth about 14*s.* of our present money. It has now become a copper coin, worth only 43·272 of an English penny.

(Fr. marbre, Lat. marmor). A term limited by geologists to the varieties of carbonate of lime which have a granular and crystalline texture. In sculpture, the term is applied to several kinds of stone susceptible of a good polish. The varieties of it are extremely numerous. The most valuable sorts used by the ancients were the *Pentelican*, which was white, and obtained from Mount Pentelicus in Attica: the *Parian*, also called *Marpessian*, obtained from the island of Paros, which was of a creamy or waxy tint, as was that from Mount Hymettus, in Attica. Thasos and Lesbos also produced white marbles, which were in much repute. A place called Luna, in Etruria, produced a marble whose whiteness exceeded that from Paros; this is the famous Carrara marble of our time. Of the white marbles were those from Mount Phelleus; from the neighbourhood of Coralios, in Phrygia; from Cyzicus, in Asia Minor; and the Marmor Phrygium, found near Synnada in Phrygia. The black marbles most used were from Tænarus, and the Numidian. The Chium Marmor, from the island of Chios, was of a dark chequered colour. The Obsidianum, procured from Ethiopia, was black. The Proconesian marble was white with black veins. Mount Taygetos afforded the Marmor Laconicum, which was green, and is better known by the name of Verde Antique. Marmor Libycum is the Rosso Antico. A marble of mingled green was obtained from Carystus. The Atrician marble, from Mount Atrax in Thessaly, was a mixture of black, white, blue, and green. The Tiberian and Augustan marbles were green, and brought from Egypt. The Marmor Memphites was green, and is what we call serpentine. Corinth produced a yellow marble. The Marmor Phengites was white, with yellow spots; the Rhodian was marked with spots of a golden colour, and that of Milos yellow (Giallo antico). In modern times the quarries of Carrara almost supply the world with white marble. Of variegated marbles there are many sorts found in this country of singular beauty; but they are not adapted for the sculptor. Ireland has supplied some beautiful specimens, but no quantity of marble fit for sculpture. France, Spain, and Portugal are all rich in marbles adapted for furniture and decoration, but not fitted for the sculptor.

Marc. The cake or refuse after expressing the oil or juice from seeds or fruits, as linseed, olives, grapes, apples, &c.; it is sometimes used for feeding cattle, as oilcake, but more commonly employed as manure.

Marcasite or **White Iron Pyrites.** A bisulphide of iron. The term Marcasite includes several varieties of Iron Pyrites, which have been named after the forms they present: viz. Cellular Pyrites, Cockscomb Pyrites, Hepatic Pyrites or Leberkies, Radiated Pyrites, &c.

It is used in the manufacture of sulphur, sulphuric acid, and sulphate of iron; but not to so great an extent as the ordinary sulphide. It was also formerly employed in jewellery and for ornamental purposes, but has now gone out of fashion.

Marcgraviaceæ (Marcgravia, one of the genera). An unimportant order of hypogynous Exogens, belonging to the Guttiferal alliance, found in equinoctial America, and remarkable chiefly for their singular cucullate bracts.

March (Lat. Martius, *the month of Mars*). The first month of the old Roman year, and the third of the English. (Sir G. C. Lewis *On the Astronomy of the Ancients*, p. 36.) In the ecclesiastical calendar used in England till the change of style in 1752, this was also the first month, as it was in the Roman. There is an old proverb still prevalent in Scotland, which represents March as borrowing three days from April, which have thence come to be designated the borrowed days. They will be found noticed in the *Complainte of Scotland*. Upon this subject D[illegible] observes, 'Those who are much addicted to superstition will neither borrow nor lend on any of these days. If any one would propose to borrow of them, they would consider it as an evidence that the person wished to employ the article for the purpose of witchcraft against the lenders.'

March. In Military language, signifies the motion of a body of troops from one place to another. It consists of three cadences: 1. slow time, in which seventy-five paces are taken in a minute; 2. quick time, in which 110 paces are taken in a minute; 3. double time, in which 150 steps are taken in a minute. In slow or quick time a pace is 30 inches, in double time 36 inches.

March. In Music, a military air, the original purpose of which is to regulate the steps and to animate the minds of soldiers. The march, however, has long been adapted to every species of musical instrument, and some of the most celebrated compositions of the greatest masters are in this style; as the March of the Priests in Mozart's *Zauber-flöte*, the Peasants' March in Weber's *Freischutz*, and above all Beethoven's Funeral Marches. A march should be always in common time; but no general rules can be laid down for its composition.

Marchantiaceæ (Marchantia, one of the genera). [Hepaticæ.]

Marches (A.-Sax. mearc, *a mark* or *boundary*). The name given to the borders or frontiers of any district; but more especially applied to the boundaries between England and Wales, and England and Scotland. The term is found in most of the Teutonic dialects. Several titles of dignity both in this and other countries derive their origin from their possessors having been appointed governors of the *marches* or frontiers of their respective countries; of these, marquis in England and markgraf in Germany are the most prominent. The title Earl of March, now enjoyed by the Duke of Richmond, was originally bestowed on Mortimer, because he was the governor or superintendent of the Welsh marches. In the middle ages, the name *marchers* was given to the noblemen who lived

on the marches of Wales and Scotland. According to Camden they had once their own laws, and even the power of life and death like petty kings; but these privileges were abolished by Henry VIII. There was formerly a court of the marches of Wales in existence, where pleas of debt, or damages not above the value of 5*l.*, were tried and determined.

Marcionites. The followers of Marcion, who in the second century adopted the Oriental notion of the two conflicting principles, and imagined that between them there existed a third power, neither wholly good nor evil, the Creator of the world and the God of the Jewish dispensation. The object of the Good Principle, or Supreme God, is to restrain the ambition of these two powers, which wage a constant war against each other as well as against Himself. For this purpose it was that He sent His Son Jesus Christ to destroy the Evil Principle on the one hand, and to counteract and coerce the power of the Jewish Deity on the other. The Marcionites were a branch of the great Gnostic heresy. Their opinions are found in the writings of Irenæus, Epiphanius, and Tertullian against them.

Marcosians. An early sect of Christians, a branch of the Gnostics, who derived their name from an Egyptian called Marcus, and reputed a magician. (Eusebius, *H. Eccl.* iv. 11.) The Marcosians had a great number of apocryphal books which they held to be canonical; and many of their fables are still in use and credit among the Greek monks.

Mare's-tail. The common name of *Hippuris*, a waterside weed.

Marekanite. A variety of Pearlstone, found at Marekan, in Siberia, in the form of small pearl-white spherules, composed of thin concentric layers.

Margaric Acid (Gr. *μάργαρον, a pearl*). This acid is obtained by the action of potash upon cyanide of cetyl. It presents the appearance of pearly crystalline scales, which melt at 140°. The name was formerly applied to an acid obtained by the saponification of several oils and fats; but this latter is now regarded as a mixture of stearic and palmitic acids.

Margarite. A hydrated silicate of alumina, lime, and soda, named from its pearly lustre.

Margarodite (Gr. *μάργαρον*). A hydrated variety of Mica, with a pearly lustre; found, amongst other localities, in the granite of the south-east of Ireland.

Margin (Fr. marge, Lat. margo, marginis, *an edge or brink*). In Printing, the arrangement of the pages in a sheet at proper distances from each other, according to the size of the paper; so that when the sheet is printed and folded, the border of white paper round them shall be regular and uniform in every leaf of the book.

Margin of a Course. In Architecture, that part of the upper side of a course of slates which appears uncovered by the next superior course.

Margites (Gr.). The title of a satirical poem numbered among the works of the cyclic poets, and attributed to Homer. (Grote's *History of Greece*, part i. ch. xxi.) The subject of the poem, which has not come down to us, was the character of a silly empty-headed man (*μαργίτης*).

Margosa-tree. One of the names of *Melia Azadirachta.*

Margrave (Ger. markgraf, count of the mark, marsh, or frontier). A title of rank formerly used in Germany, and equivalent to the English marquis. [MARQUESS.]

Maria Theresa, Order of. A military order of Austria, consisting of grand crosses, commanders, and knights: founded in 1757.

Marigold. A name given to various garden flowers. The common Marigold is *Calendula officinalis*; African and French Marigolds are species of *Tagetes*; and what is called Corn Marigold is *Chrysanthemum segetum.*

Marine Glue. A cement made by dissolving equal parts of shell lac and caoutchouc in separate portions of rectified naphtha, and mixing the warm solutions.

Marine Metal. An alloy of lead and antimony with about two per cent. of mercury, introduced in 1833 by Wetterstedt for sheathing ships.

Marines (Lat. marinus, *belonging to the sea*). A corps of men enlisted to serve as soldiers on board ships of war and on shore under certain circumstances. They sometimes assist, particularly in the British service, in performing seamen's duties on board. Marines were first embodied in 1664. In 1684 mention is made of the duke of York's maritime regiment of foot; and in the reign of William III. several regiments were placed on the establishment: these, however, were subsequently disbanded. In the beginning of Queen Anne's reign, six regiments of maritime soldiers were raised; and though these were again disbanded in 1749, six years afterwards 130 companies were raised on the recommendation of Lord Anson, consisting in all of above 5,000 men. Since the commencement of the present century great additions have been made to this corps; and at present its strength amounts to 17,000 men, divided into four divisions (in 116 companies) of light infantry and one division (in twenty-four companies) of foot artillery. The men are clothed and armed in the same manner as the infantry of the line and artillery respectively. Commissions in the corps are not obtainable by purchase; and the officers rise by seniority, in the artillery and infantry respectively, from the rank of second-lieutenant to that of general. The staff of the regiment consists of an inspector-general, or deputy adjutant general, and an assistant adjutant general. The corps takes military rank between the forty-ninth and fiftieth regiments of foot. The officers have all army rank; which may be the same or higher than that which they hold in the corps.

Marionite. A variety of hydrated carbonate of zinc, found in Marion county, Arkansas.

Mariotte's Law. In Pneumatics, a general property of elastic fluids, namely, that the

elasticity or pressure is directly proportional to the density; or, which is the same thing, inversely proportional to the space which the fluid occupies. [PNEUMATICS.]

This important relation between the elastic force and the density of gaseous matter, ought, in justice to the first discoverer, to be called *Boyle's Law*. In a tract published at Oxford in 1668, under the title of *New Experiments touching the Spring and Weight of the Air*, Boyle announced that the spring—that is to say, the elastic force—of air is directly proportional to its compression; which is equivalent to saying, that the elastic force is directly as the density, or inversely as the volume, under the same temperature. Boyle's experiments were made on atmospheric air confined in the closed end of a U-shaped glass tube, and compressed by the weight of a column of mercury. It does not appear that he took the precaution to expel the moisture from the air, and the greatest pressure he applied was only equal to four atmospheres; so that it may, perhaps, be said that his experiments were neither sufficiently accurate nor extensive to establish the general law, even in respect of atmospheric air, without mentioning the other gases. Mariotte's experiments were described in the *Memoirs of the Paris Academy of Sciences*, published about eleven years later, namely in 1679, without any reference to Boyle's announcement, which was possibly unknown to him; and as it was through this channel that the law became known to the continental philosophers, who were the first to perceive its importance, they naturally distinguished it by the name of the person whom they supposed to be its discoverer.

The relation in question has recently been investigated by M. Magnus of Berlin and M. Regnault of Paris, in a series of experiments, conducted with the utmost attention to every circumstance affecting their accuracy; and the results are interesting. If v denote the volume of a gas under the pressure p, and v' its volume under pressure p', then the law gives $vp = v'p'$, whatever the pressures may be, if the temperature remains unaltered. But, on comparing the results of his experiments, M. Regnault has found that the above equation is not strictly true for any gas; and that, assuming $vp = v'p'(1+q)$, where q is a small correction, the value of q increases with the pı . Thus the elastic force of atmospheric air at great pressures is slightly less than it would be if the law were strictly true. With respect to carbonic acid, the deviation is considerably greater. In the case of hydrogen the correction q becomes negative, so that while air and the other gases experimented upon were more compressed than they would be if the law were exactly followed, hydrogen was less compressed, and its compressibility was found to diminish as the pressure increased. But temperature has a considerable influence on these results; and as it was found that the deviation from the law diminishes as the temperature is increased, M. Regnault concludes that the law is only rigorously true when the gases are infinitely dilated, and that it becomes less and less exact in proportion as they are in a state of greater condensation. (*Mémoires de l'Institut*, tome xxi.)

Maritime Law. The law relating to harbours, ships, and sailors. It forms an important branch of the commercial law of all trading nations, and embraces an infinite variety of subjects, most of which have been defined under their respective heads. The most celebrated codes of maritime law have been: in ancient times, that of Rhodes; in modern times, the *Consolato del Mare*, a compilation supposed to have been framed at Barcelona as early as the ninth century; the laws of the Isle of Oleron, in the time of Richard I. of England; the laws of Wisby in the island of Gothland, to which some northern jurists have assigned an earlier origin than the laws of Oleron, but which there can be little doubt were merely a compilation from those above specified. But by far the most complete and well-digested system of maritime jurisprudence that has ever appeared is comprised in the *Ordonnance de la Marine*, issued by Louis XIV. in 1681, by which maritime law was elevated to the rank of a regular system, and which has formed the basis of many of the subsequent decisions of English, American, and other foreign courts. This excellent code was compiled under the direction of Colbert, by men of great talent and learning, after a careful revision of all the ancient sea laws of France and other countries, and upon consultation with the different parliaments, the courts of admiralty, and the chambers of commerce of the different towns. It combines whatever experience and the wisdom of ages had shown to be best in the Roman laws, and in the institutions of the modern maritime states of Europe. The edition of it, with a commentary, by Valior (La Rochelle 1766) is a standard work. In the preface to his treatise on the *Law of Shipping* (of which the edition by the present Mr. Justice Shee, 1856, forms the best English compendium on the subject) Lord Tenterden says, 'If the reader should be offended at the frequent references to this ordinance, I must request him to recollect that those references are made to the maritime code of a great commercial nation, which has attributed much of its national prosperity to that code—a code composed in the reign of a politic prince; under the auspices of a wise and enlightened minister; by laborious and learned persons, who selected the most valuable principles of all the maritime laws then existing; and which, in matter, method, and style, is one of the most finished acts of legislation that ever was promulgated.' [ADMIRALTY, COURT OF.] In addition to the well-known English work above cited, may be mentioned Ortolan, *Règles Internationales de la Mer*, 1845. A very important addition to the public law on this subject, bind-

ing at least on those powers which were parties to it, was made by the 'Declaration respecting Maritime Law' of the congress at Paris, 1856, by which privateering was abolished, the neutral flag admitted to cover enemy's goods, &c. It is printed in the Appendix to Phillimore's *International Law*, vol. iii.

Marjoram. One of the aromatic herbs cultivated for culinary use. There are two principal sorts used, Winter Marjoram, *Origanum heracleoticum*, and Sweet or Knotted Marjoram, *Origanum Majorana*.

Mark. An old coin current in England and Scotland, valued 13*s*. 4*d*. A piece of money so called is at present used in Hamburg; it is equal to 1*s*. 4*d*. sterling.

Mark, Order of St. A Venetian order of knighthood; St. Mark the Evangelist having been the patron of that republic.

Market. [TRADE, HOME.]

Marking Ink. [INK.]

Marking Nut. In Botany, the seed or nut of the *Semicarpus Anacardium*, a tropical tree, related to the cashew nut. It derives its name from the fact that the juice contained in its fruits stains linen of a deep and indelible black colour..

Marl (Dutch marghel, from margh, *marrow*, whence marghelen, *to fatten land*). Marl is a mixture of carbonate of lime and clay in various proportions, and of different degrees of compactness and friability. In some marls the proportion of clay is small, in which case it acts on soils much in the same manner as chalk; but where clay is the predominant ingredient, it acts principally by altering the texture of the soil. Hence sandy soils are improved by marl, in consequence of its increasing their compactness and capacity for retaining moisture; while argillaceous marls applied to clays are of little or no use. From these long-established facts has arisen the old adage—

Who marls sand shall buy the land,
Who marls clay throws all away.

Marl is found in almost every country; not like limestone, in protruding rocks, but (from its friable nature, which causes it to moulder down into a comparatively earthy mass) under or near the surface of the soil, whence it is dug out and spread on the surface. Hence, while limestone is quarried, chalk and marl are dug out of pits. Marl has been in use in Europe since the time of the Romans. It is very generally used as a manure in France and Germany. In England it is most used in Norfolk.

Marling Spike. An iron bolt or pin, tapering to a point, for opening the strands of rope preparatory to splicing.

Marmatite. A variety of Blende in which iron, and sometimes cadmium, takes the place of a part of the zinc. It is found at Marmato, in South America.

Marmolite (Gr. μαρμαίρω, *to shine*). A foliated variety of Serpentine from Hoboken in New Jersey.

Marmoratum (Lat.). In Architecture, a cement formed of a mixture of powdered lime and marble.

Marmose. The *Didelphis murina* of Linnæus, a small species of opossum, in which the marsupial pouch is suppressed, being represented by two folds of the abdominal integument.

Marmoset. A name frequently applied to the Ouistiti (*Hapales Jacchus*), and to other allied species of South American monkeys.

Marmot (Fr.). The Rodent animal so called is the type of a genus (*Arctomys*) nearly allied to the squirrels, being characterised by having five molar teeth on each side of the upper and four on each side of the lower jaw, all bristled with points, and indicative of a somewhat mixed diet. The marmots, however, in their general form are nearly the reverse of the squirrels, being heavy, with short legs, a middle-sized or short tail, and a large flat head. They pass the winter in a state of torpor, concealed in deep holes, the entrance of which they close with a heap of dried grass. They are natives of Europe and North America, live in societies, and are easily tamed.

Maronites. The followers of Maro, inhabitants of the mountains Libanus and Antilibanus in Syria, who adopted in the seventh century the opinions of the Monothelites. They continued to form a separate sect until the twelfth century, when they became reconciled to the see of Rome. The Maronite writers, however, have always maintained their freedom from the errors imputed to them, and declare themselves to have been uniformly attached to the doctrines of the Catholic church. [MONOTHELITES.]

Maroons (supposed to be derived from a word used in Spanish America, signifying *hog-hunters*). A name given in Jamaica to runaway negroes. When Jamaica was conquered from the Spaniards, a number of negroes, abandoned by their former masters, occupied some of the mountainous parts of the island, and caused great trouble to the colonists. About 1730 they became extremely formidable, but after a war of eight years they at length submitted to a capitulation, by which they were allowed to retain their free settlements in the heart of the island. In 1795 a portion of them again rose in arms, but were speedily put down, and transported to a new settlement in Nova Scotia. (Dallas's *History of the Maroons*.)

Marque, Letter of. A commission granted in time of war to a private person commanding a vessel to cruise at sea and make prize of the enemy's ships and merchandise; the ship so commissioned is sometimes called by the same name. [REPRISALS.] The word is derived from mark (Ger. *frontier*), as being a right of capturing property beyond the limits or frontiers of another prince.

Marquess. A title of dignity in England, France, and Italy, next in rank to that of duke. [MARCHES.] It is of German

origin; those military chieftains in the Teutonic kingdoms and empires which arose on the fall of the Western empire, who were intrusted with the defence of districts on the frontiers, having been styled *mark-grafen*, *margraves*, counts of the marches or frontiers (in Latin, marchiones). Many of these officers were appointed by Charlemagne, although he was not, probably, the first creator of the office. According to the ordinary course of the developement of feudal institutions, these chiefs, from military governors appointed for life, became territorial potentates, holding their lands by hereditary right; and, on the decay of that system, this honour, like others, became merely titular. In England, the first marquess was Robert de Vere, earl of Oxford, created by Richard II., in 1387, marquess of Dublin for life. The next creation was of John de Beaufort, earl of Somerset, raised to the rank of marquess in 1397, which dignity he afterwards refused to bear, as a strange and novel one. (Nicolas, *Introduction to the Peerage*, lxxvi.) After that period the title fell into disuse until the reign of Edward VI.

Marquetry (Fr. marqueterie). In Architecture, inlaid work consisting of different pieces of many-coloured woods glued on to a ground usually of oak or fir, well dried and seasoned, which, to prevent casting or warping, is composed of several thicknesses. The early Italian builders used marquetry in cabinet work; and John of Vienna, and others of his period, by its means represented figures and landscapes; but in the present day it is chiefly confined to the ornamentation of floors, in which the various pieces of wood are usually disposed in regular geometrical figures, and are rarely of more than three or four species.

Marriage, Law of, in England. Previous to the passing of the first Marriage Act in 1754, the law of England was governed by the canon law; and, consequently, an agreement to marry, followed by consummation, formed, as it now forms in Scotland, a sufficient union. That statute first rendered necessary the preliminaries of the publication of banns, or the obtaining a license. It was amended by 4 Geo. IV. c. 17. But that Act imposed so many additional restrictions on parties wishing to become husband and wife, that it was found necessary to repeal it in all haste, and another statute was passed (4 Geo. IV. c. 76), by which English marriages were next regulated.

By this Act the banns of marriage are to be published three Sundays in a parish church, or public chapel of the Establishment, in the parish wherein both, or the parish wherein each, of the parties dwell. A license is a dispensation by virtue of which marriage may be solemnised without the publication of banns. It is granted by *surrogates*, or persons having authority from the bishop. No license can now be obtained, unless upon affidavit that the parish or district in which the marriage is to be solemnised has been the usual place of residence of one of the parties for fifteen days immediately preceding the granting of the license. The affidavit must also declare that there is no impediment of kindred or alliance, nor any other lawful cause of hindrance.

By the Marriage Act 6 & 7 Wm. IV. c. 85 (amended by several subsequent Acts) a superintendent registrar of marriages was appointed, who is required to register marriages, and empowered to give licenses, &c., either himself or by inferior registrars. Places of worship, certified according to law, may be registered for the solemnisation of marriages, or they may be celebrated before the superintendent registrar himself; thus entirely removing the contract from ecclesiastical control. But all parties may, if they please, still marry in the parish church. A complete registration of marriages is provided by the same Acts.

A special license dispenses with all restrictions as to time and place of marriage. By a regulation of Archbishop Secker it is not to be granted except to persons of a specified rank; but in practice the privilege is extended as a matter of favour.

The power of parents and guardians, in restricting the marriage of minors under their tutelage, is now confined within the following limits. The publication of banns is void, if the parent or guardian of either party declare, or cause to be declared, their dissent in public at the time of the proclamation. In case of marriage of a minor by license, the father or guardian, or if none, the mother or the guardian appointed by the Court of Chancery, must give consent, and such consent must be notified in the affidavit on application for the license. If consent be unreasonably withheld, the only resource of lovers against the flinty hearts of parents or guardians is by petition to the lord chancellor, who may, if he please, interpose his judicial authority in favour of their union.

Marriages are void if solemnised in a wrong name. They are also void where there is a prior existing marriage, and in case of lunacy or incapacity, or of relationship within the prohibited degrees.

Proof of a marriage is by the evidence of a party who was present at the celebration; or by production of the parish register, and showing the identity of the parties.

Marriage is voidable by legal proceeding, where such marriage has been contracted under a canonical impediment, such as bodily incapacity of either of the parties. Marriages solemnised by force are also voidable, and such as are contracted in error under certain circumstances. A voidable marriage is good to all intents until rendered void by a sentence of the court.

Other matrimonial causes are—1. Jactitation of marriage. When one party gives out or reports that he or she is legally married to another, the person injured may obtain a decree condemning the other to *silence*, with the costs of the proceeding; and unless the defendant proves marriage, silence is enjoined, which is the only remedy the matrimonial court can give.

The Ecclesiastical Courts had until 1857 the cognisance of *matrimonial causes*. But in that year, by the Act 20 & 21 Vict. c. 85, their jurisdiction in this respect was entirely abrogated, except for the purpose of granting marriage licenses: and was transferred to a new Court of Record, entitled the Court for Divorce and Matrimonial Causes. At the same time very important changes in the law itself, as regards these proceedings, were effected.

The powers of this court now extend to—

1. Decrees establishing the nullity of marriages contracted under legal impediment.

2. In suits of jactitation of marriage: that is, where one party falsely asserts that he or she is married to the other.

3. Sentences of judicial separation: which have the effect of what under the former law was termed a divorce *à mensâ et thoro*: and may be obtained by either party on the ground of adultery, or cruelty, or desertion without cause for two years.

4. Dissolution of marriage: which may be obtained on the suit of the husband for the wife's adultery, and on the suit of the wife for adultery and cruelty, or adultery with incest or certain other aggravations. Until 1857 divorce à vinculo had been legally unknown in England, as it is in countries governed by the maxims of the canon law, and could only be obtained through the medium of a special Act of Parliament. In that year, by the Act 20 & 21 Vict. c. 85, it was for the first time rendered generally lawful. At the same time, the old action for damages for *criminal conversation* was abolished; but the husband may still claim damages from the adulterer, either in his petition for divorce or separation, or by a distinct proceeding.

5. A suit for restitution of conjugal rights is to compel mutual cohabitation. It is doubtful whether any deed of separation, or anything short of a sentence by the court, can bar the complainant of his or her right to promote this suit; but cruelty or adultery may be pleaded in reply, as constituting lawful grounds for separation.

6. Alimony is that legal proportion of the husband's estate which, by the decree of the ecclesiastical court, is allotted to the wife for her maintenance during the pendency of a suit between them; or after a sentence of divorce à mensâ et thoro by reason of the cruelty or adultery of the husband, the permanent allowance to be paid to the wife during their separation. The quantum of alimony is decided by the court on consideration of the whole circumstances of the case: e.g. a third or a moiety of the husband's property.

Marriage, its Effect on Property.—The consideration of the legal effect produced by marriage on the property of the parties contracting it divides itself into—

The law of husband and wife: 1. As it respects property acquired by either before or after marriage.

2. As its dispositions are affected by separation or divorce.

As to real property. If the wife is seised of lands or tenements in an estate of inheritance, and dies having had issue born living, the husband is entitled to the lands or tenements for his life, being tenant, as it is termed, by the curtesy of England; and this, whether the lands be held by a legal or equitable title.

Dower is now, since the statute 3 & 4 Wm. IV. c. 105, the wife's right to one third part, for life, of all estates of inheritance which her husband dies solely entitled to in possession. It formerly attached to all estates of inheritance of which he was at any time possessed, so that he could not defeat her title by alienation, but to legal estates only. Since the 1st January, 1834, the period at which the above-mentioned Act came into operation, equitable estates are also subject to it. It has long been customary to bar this right to dower by various complicated processes, which the law has permitted to defeat the wife's claim; and especially by settlements before marriage, giving a jointure or provision in lieu of dower. It may now be barred by the husband's alienation in his lifetime; or by his will; or by a declaration in the deed of conveyance of the land to the husband. Anciently a *feme covert* could only alienate real property by the public solemnity of a *fine*; but now she may do this by a deed executed after her examination by commissioners, to show that no control is exercised by the husband.

As to personalty: all the *personal* property to which a woman is entitled vests in her husband by marriage. Her *chattels real*, that is, leasehold property for a term of years, will revert to her if she survive him; and although the husband may alienate them in his lifetime, he cannot dispose of them by will. But should he survive her, they are his absolutely. Her *chattels personal*—money and goods— are his without restriction, to give or bequeath as he pleases even in her lifetime. Her *choses in action* (that is, property of which there is no immediate occupation, as debts due to her, money in the funds, &c.) are the husband's property *conditionally*; that is, if he reduce them into possession by exercising his rights over them during her life. If not, they survive to her absolutely; and should she die first, he only takes them as her administrator, which he is by right. Any property, however, whether real or personal, may be given to a woman for her separate use, which will exclude the husband's right, and she may be restrained from alienating the property during coverture.

If the husband die intestate, the wife is entitled to half his personal property if there be no issue, and to one-third if there be issue.

The husband is liable for all his wife's debts and engagements made while unmarried; but not for such as she may have contracted during a former marriage. But he is released from his liability by her decease; and if he die first, she only is responsible. For debts contracted by the wife during marriage the husband is not

liable unless they have been contracted with his consent, express or implied; and this implied assent gives rise, as may well be supposed, to numberless questions in courts of law.

As to the acts of husband and wife before marriage. Since 1837 (1 Vict. c. 26), 'Every will made by a man or woman is revoked by his or her subsequent marriage,' except in certain peculiar cases where made under a power of appointment.

Marriage settlements are contrivances to modify the effects which would be produced by the mere act of law on the rights of the respective parties; and also to insure a provision for issue. It is usual to vest the property of both parties in trustees; generally for the benefit of the husband during their joint lives, then for the benefit of the survivor, after his or her death for the benefit of the children, in such proportions as the nature of the property or circumstances of the family may dictate. But it is usual to give authority to the parents by means of a *power* to vary the children's relative proportions. A jointure, although, in the strict sense of the word, a joint estate to husband and wife, is in practice usually a rent charge to the wife, secured on land, to take effect immediately on the husband's death, and to secure a competent provision for her during her life at least; it is usually provided by settlement, and bars dower. Pin-money is an annual income settled before marriage by the husband on the intended wife for her personal expenses.

But in other cases, and especially when the casualties of a trade render it desirable to secure a certain protection, it is very common to give the first life interest in the settled property, or part of it, to the wife for her separate and inalienable use, free from the debts or control of the husband. Where bequests are made to a married woman for her separate use, and no trustees are named to protect them, a court of equity will consider her husband a trustee for her. She may sue him, or any other person, in those courts, in respect of such property. Her savings out of it are likewise hers in separate right.

A married woman has also a claim, in a court of equity, to a provision out of her own property in several cases, especially where the husband deserts or ill-treats her, or where, being a ward of chancery, she is clandestinely married; and recent legislation has given her in many instances a more summary remedy in such cases. A husband is not held liable for debts contracted by his wife, even for necessaries, if he have turned her out of doors for adultery; or if, after being turned out, she commit adultery; or if she depart from him without his consent; or if she elope with an adulterer; or if the husband and wife separate by mutual agreement, in cases where the wife has separate means, or is provided for by separate maintenance. As to the effect of divorce or separation on property: the sentence of a court pronouncing a marriage void ab initio destroys the husband's rights over the property of the wife. And dower is lost if the wife elopes and lives in adultery, or is attainted of treason or felony. Under the recent Acts of Parliament regulating divorce, the court has large power, both in cases of divorce à vinculo and of judicial separation, to make such orders respecting the property of the parties, even though in settlement, as may be thought expedient for the benefit of the children and of the parties themselves. On judicial separation obtained by a wife on account of the misconduct of the husband, she is entitled to *alimony* out of the husband's property [see above].

Lastly, as to criminal law: bigamy, or polygamy, is a felonious offence, punishable by penal servitude; and is now (since the statute 9 Geo. IV. c. 31) equally punishable, although the second marriage took place out of the jurisdiction of English law.

A wife committing any felony, except murder or manslaughter, in company with her husband, is not responsible for the offence; but she is indictable for high treason so committed.

Absence of Husband or Wife for a period of seven years is allowed by 24 & 25 Vict. c. 100, s. 57, as an exemption from the penal consequences of bigamy.

Marriage, Law of, Foreign. By the law of Scotland, marriages merely contracted by declaration, acknowledgement, or before witnesses, are held valid. By that of France, and all countries in which French jurisprudence is established, marriage is a civil contract only, regulated by articles 144 and following of the Code Civil. It cannot be contracted by a male before eighteen, or by a female before fifteen. The consent of the father and mother (if dissentient, the father overruling) is required until twenty-five and twenty-one respectively; and until thirty and twenty-five this consent must still be applied for, although marriage celebrated without it is not void. Marriages within prohibited degrees are absolutely null. But marriages in other respects contrary to the law are annullable on application of the proper parties.

Dissolution of marriage can only arise by death, natural or civil, that is by way of legal punishment. Divorce is altogether illegal, having been introduced into the law only in 1792, and expunged from it in 1816.

In the United States of America, marriage is likewise a civil contract only, but it is regulated by the laws of each state respectively.

The question of the validity in one country of marriages good according to the laws of another, is one of the most complicated, it may be added, one of the most unsettled, which remains in international jurisprudence. If married citizens of one country transfer their domicile to another, their marriages are, of course, valid in the country of their adoption, whether in accordance or not with the law thereof. But when the citizens of one country marry in another country, questions of great difficulty, and which, as has been said, no general agreement of jurisprudence has settled, are apt to arise; and these are still further complicated when the parties contracting

marriage are of different nationalities. As a general rule, marriage, like other contracts, is to be judged of by the *lex loci*. Consequently two English subjects marrying in France, according to the formalities of French law, contract a marriage valid in England. On this principle, the so-called *Gretna Green marriages* by English persons in Scotland were valid until checked by Act of Parliament in 1856. But, in the language of Mr. Story, 'the most prominent, if not the only known, exceptions to this rule are those involving polygamy and incest; those positively prohibited by the public law of a country from motives of policy; and those celebrated in foreign countries by subjects entitling themselves under special circumstances to the benefit of the law of their own country.' (*On the Conflict of Laws*, ch. v.) On this principle it has been recently decided, though not without considerable question, that a marriage by an Englishman with his deceased wife's sister, contracted in Germany, where such marriage is lawful, is invalid here. French jurisprudence, it may be added, appears to be more jealous of the maintenance of its own special marriage law in the case of marriages contracted by Frenchmen in foreign countries, than is our own.

Marrow, Vegetable. A variety of *Cucurbita ovifera*, cultivated for the sake of its fruits, which in the young state form a delicate esculent.

Marrubium. The genus of Labiate plants which includes the Horehound, an erect branching greyish-looking herb, with roundish wrinkled leaves, and whitish flowers crowded in the axils. It is found wild in this country, as well as throughout Northern Asia and Europe, and has bitter tonic properties. It is a favourite domestic remedy in chest complaints.

Mars (Lat.). In the Solar System, one of the old planets, and the fourth in the order of distance from the sun. The mean distance of Mars from the sun is 1·5236923, the mean distance of the earth from the sun being 1: it is, consequently, about 142,000,000 miles distant from the sun. Mars performs his mean sidereal revolution in 686·979 mean solar days, and his synodical revolution (that is, his return to the same position in respect of the earth and sun) in 779·82 days. His orbit at the beginning of the present century was inclined to the ecliptic in an angle of 1° 51′ 6″; and its eccentricity is ·093311. His apparent diameter varies from 3·6″ at his greatest, to 18·28″ at his least, distance from the earth. At his mean distance the apparent diameter is 6·29″. The diameter of the planet (in which the ellipticity is extremely small) is 4,113 miles. Mars has a rotation about his axis which is performed in 24 h. 39 m. 22·62 sec., according to the latest researches. The inclination of the axis to the ecliptic is 28° 51′; the longitude of the pole of the planet being 349° 1′.

In consequence of the position of Mars in the system, and his eccentric orbit, he is sometimes so near to us that it is possible by means of powerful instruments to scrutinise his surface rather closely; and it is not too much to say that at the present time materials exist for the construction of a map of the equatorial and southern parts of the planet, which shall show the position and outlines of the continents and seas with some degree of accuracy. As the north pole of the planet is tipped away from us when most favourable oppositions occur, so much cannot be said for the northern hemisphere.

To the other points of interest furnished by the planet must be added that of resemblance to our earth. That it has land and water, winter snows, summer thaws, and wind-borne clouds, has now been placed beyond all doubt, and it has been shown that its extreme temperatures are probably not far different from our own. The water shows itself in the telescope by a greenish tint, while sometimes the land appears red, and on this account it was once supposed that something like a red sandstone formation had a large developement in our sister planet; but close observation in 1862 led one of the observers to surmise that this red colour might be due to the absorption of the planet's atmosphere. This suggestion has since been confirmed by means of spectrum analysis. The dazzling brilliancy of the polar snows (which are not always concentric to the pole of rotation) when observed near the limb of the planet is such that by an effect of irradiation they appear to project beyond it. The rate at which the snow melts is sometimes extremely rapid, and as a result the snow cap is reduced at a period equivalent to our July to an extremely small patch lying very near the pole. Some recently published drawings of the planet by Lord Rosse and another observer will be found in the last volume of the *Memoirs of the Royal Astronomical Society*.

Mars or **Mavors.** An ancient Latin god, early identified with the Greek Arês, but essentially distinct in conception from the idea of that god. [Ares.] The Sabine and Oscan form of the word was Mamers, and Mars itself is contracted from Mavors or Mavers. At Rome he was honoured as the progenitor of Romulus, the founder of the city, of which he was held to be the protector; and in his honour the Latin husbandmen used to offer up a sacrifice, called *suovetaurilia*. [Lustratio.] The priests of Mars were called *salii*, and to their care was intrusted the sacred shield (*ancile*) which was said to have fallen from heaven during the reign of Numa. [Ancile; Salii; Thor.]

Marseillaise Hymn. The origin of this song, which has played so important a part in the revolutions not only of France but of other continental states, was long involved in obscurity; but there seems to be now little doubt that both the words and music were the production of Rouget de Lille, a French officer of engineers, who was quartered at Strasburg in the year 1792, when Marshal Luckner commanded the army, at that time entirely composed of young conscripts. According to a story which seems well authenticated, they

were first produced in society by the author at the house of Baron Dietrich, in that city, in April of that year, as the *Chant du Départ de l'Armée du Rhin.* It is, however, necessary to add, that a claim for the music has been advanced, and pretty strongly supported, on the part of the Germans: on the supposition that it is borrowed from the *Credo* of a mass composed by Holzmann.

The song is said to have been styled the *Marseillaise Hymn* from a body of troops, on their march from Marseilles, having entered Paris playing that tune at a time when it was little known in the capital. See the subject fully discussed for the last time, in an article contributed by M. A. Rouget de l'Isle to the French journal *l'Intermédiaire* for Sept. 20, 1864.

Marsh (Old Eng. mareis, Fr. marais, Lat. mare, *a sea* or *pool*). The name given by geographers to districts maintained in a state of moisture by the waters of a river, or of springs which cannot find an easy vent; the drainage of some of these marshes, such as the Harlem Meer, the Whittlesea Mere, &c. constitute the greatest triumphs of modern engineering.

MARSH. A flat surface, the soil of which is so far saturated with water throughout the year as to be unfit for culture by the spade or plough; but not so much as to prevent it from producing coarse grasses, and other kinds of herbage. Marshes are generally situated in bottoms, where they are kept moist by the water which descends from the surrounding lands; or along the banks of rivers or lakes, where their humidity arises from their being nearly on the same level with the adjoining water. Where a marsh is situated so as to be occasionally overflowed by the sea, or by a river up which the tide flows, it is called a salt marsh; and the herbage produced by such lands is found highly conducive to the health of animals which pasture on them for a certain portion of the year, from the alterative effect of its saline properties.

Marsh Gas. *Fire-damp, light carburetted hydrogen*, or *hydride of methyl.* This gas is evolved in large quantities from the seams in coal-mines, and is also one of the gaseous exhalations from marshes and stagnant pools. It is always present in coal-gas, mixed however with other gases. It can be prepared artificially either by bringing zinc methyl into contact with water, or by heating a mixture of 2 parts of acetate of soda, 2 of caustic potash, and 3 of powdered quicklime. It is inodorous and tasteless, and its feebly luminous flame deprives it of all value as an illuminating agent. This gas is a compound of 2 atoms of carbon and 4 of hydrogen (C_2H_4).

Marsh Miasma. The infectious vapour which rises from certain marshes and marshy soils, and which tends to produce intermittent and remittent fevers.

Marsh's Apparatus. An apparatus for the detection of arsenic. When a jet of pure hydrogen gas is inflamed, and a surface of white porcelain held in the flame, there is no metallic deposit; but if the hydrogen contains a trace of arsenic, a steel-grey deposit of metallic arsenic is observed surrounded by a black ring of the suboxide. This test was first suggested in 1836 by Mr. Marsh of Woolwich, who at the same time described a convenient apparatus for the purpose. Antimony may be similarly detected. The requisite precautions in the use of this apparatus are fully detailed by Dr. Taylor in his *Treatise on Poisons*, chap. xxiii.

Marshal (Low Lat. marescalcus, Ger. marschall, from Old Ger. mähre, *a horse*, and schalk, *a servant*). A title of honour in many European countries, applied to various dignities and high offices. The title of Marshal of England is now hereditary in the family of the dukes of Norfolk. William Fitz-Osborn and Roger de Montgomery are said to have been marshals to William the Conqueror: their successors for some time are not accurately known; but the office was held in 1138, in fee, by the family of Clare, and thence descended to the earls of Pembroke, and thence to Roger de Bigod, earl of Norfolk, who surrendered it to Edward I. After being granted for life, and during pleasure, to several successive marshals, the dignity, with the title of Earl Marshal, was given to Mowbray, afterwards duke of Norfolk; in whose family the dignity subsisted until it reverted to the crown in the reign of Edward IV. Richard III. granted it to his favourite, Howard, duke of Norfolk; after whose death and attainder it passed through many hands, but was by Charles I. granted for life to his descendant, Thomas Howard, earl of Arundel; and finally his grandson, Henry Howard, earl of Norwich, was constituted hereditary earl marshal of England in 1672, with remainder to the issue male of the earl of Arundel aforesaid; in which latter line it now subsists. The earl marshal is eighth in rank among the great officers of state in England. He has the same jurisdiction over the court of chivalry which was formerly exercised by the constable and marshal jointly.

MARSHAL. In Military affairs, an officer of very high rank in the armies of great powers. The history of the title is a little complicated. The commander of the French forces is for the first time styled *marshal of France* under Philip Augustus. The Estates of Blois under Henry III. fixed the number of Marshals of France at four. Louis XIV. raised it at one time to twenty. Napoleon styled them 'Marshals of the Empire.' In 1839 the number of Marshals of France was fixed at six in time of peace, twelve in time of war.

But the *field marshal*, or *maréchal de camp*, at one time, it is thought, superior in rank to the *marshal of France*, became early in French military history his subordinate. *Maréchal de camp* became synonymous with *aide-maréchal*, an inferior functionary, charged with commissariat and encampment duties, and is now the

title of an officer below the rank of lieutenant-general.

In Germany, the title *field marshal* was borrowed originally from France, and instead of sinking in dignity, has gradually risen. In the Thirty Years' War the commander of an army was styled *general*, the *field marshal* answering to the *quartermaster-general* of modern armies. In the last century the office of field marshal attained its present dignity, next to that of a commander-in-chief, and has been adopted in this sense from German usage by other military nations, ourselves among the number.

Marshal of the King's Household or **Knight Marshal.** An officer whose business is said to be to hear and determine pleas of the crown, and suits between persons of the king's household and others within the verge. The marshal of the Queen's Bench has the custody of the Queen's Bench prison in Southwark.

Marshalling. In Heraldry, the arrangement and distribution of coats in a shield so as to denote the several matches and alliances of the family. [BLAZONRY.]

Marshalsea. In Law, the court or seat of a marshal. The King's Bench prison, in Southwark, was so called because the marshal of the king's house was wont to sit there, or to keep his prison. The Marshalsea, or Knight Marshal's Court, held pleas of trespasses committed within twelve miles round Whitehall where one, and of debts &c. where both, of the parties belonged to the royal household. It was abolished in 1849.

Marsilea (after Count L. F. Marsigli, founder of the Academy of Sciences, Bologna). The *Marsileaceæ* form a natural order of pseudo-ferns, consisting of a few aquatic genera, the chief of which is *Marsilea*, known by its creeping rhizome, and erect long-stalked leaves having two pairs of leaflets disposed in a cross. The spores grow on receptacles which often spring from the rhizome. The Nardoo of the Australian continent is *M. macropus*.

Marsupials (Lat. marsupium, Gr. *μάρσυπος, a pouch*). An order of Implacental Mammiferous quadrupeds, of which the females have a portion of the abdominal integument folded inwards, forming either a depression containing the mammæ, or a pouch serving also as a temporary abode for the young; and the males have a corresponding portion of the abdominal integument extended outwards, forming a scrotum or pedunculate bag for the testes. In both sexes, with one exception, two supplementary trochlear bones are developed in the internal pillars of the abdominal rings, and are articulated to the anterior part of the brim of the pelvis, around which bones plays the muscle supporting and compressing the testes in the male, and the mammary glands in the female: the trochlear ossicles, from their connection by means of these muscles with the pouch, are called *marsupial*. The angle of the lower jaw in marsupials is more or less inverted.

The quadrupeds associated together by the common external and osteological characters above defined so far resemble the oviparous animals that a placenta is not organised, and the chorion of the fœtus contracts no adhesion with the parietes of the uterus. The fœtus is prematurely born after a gestation of only thirty-eight days, in the great kangaroo, in which it does not exceed an inch in length. It is then received into the pouch, and adheres to the nipple for many months before it quits the pouch. The generative organs themselves, both male and female, offer several striking peculiarities common to all the Marsupials, and by which they differ from the ordinary Mammalia. Cuvier accordingly, in 1816, separated the marsupial from the other unguiculate quadrupeds, to form a distinct group, which he describes as forming with the Monotremes a small collateral chain; all the genera of which, while they are connected together by the peculiarities of the generative system, at the same time correspond in their dentition and diet, some to the Carnivora, others to the Rodentia, and a third tribe to the Edentata. M. de Blainville, in the Tables of the Animal Kingdom which he published in the same year, 1816, constituted a distinct sub-class of Cuvier's 'small collateral chain' of mammals, and gave to the subclass the name of *Didelphes*, in antithesis to that of *Monodelphes*, by which he distinguished the Placental Mammalia.

Many acute and sound-thinking naturalists refused their assent to these views, which, as they were supported by a knowledge of the conformity of organisation of only the generative system in the Marsupials, were unquestionably defective in the evidence essential to enforce conviction. The best arguments for returning to the older views of classification, and for distributing the marsupial genera, according to the affinities indicated by their dental and locomotive systems, among the different orders of the Placental Mammalia, were advanced by Mr. Bennett, the accomplished author of *The Gardens and Menagerie of the Zoological Society delineated* (vol. i. p. 265); and these have been repeated with approbation, and adopted by later classificators, as Mr. Swainson.

The discovery of the true affinities of the Marsupialia could only flow from an insight into their whole organisation; and the question which Mr. Bennett proposes, with reference to the genus *Phascolomys*, 'What is there of importance in the structure of the wombat, except this solitary character of the marsupium, to separate it from the Rodent order?'—a question which he might, in 1831, have asked with equal force in reference to any other marsupial genus—could only be answered satisfactorily by the anatomist who had submitted the Marsupialia in question to a thorough dissection.

Although the Marsupials present modifications of the dental system corresponding with the carnivorous, omnivorous, and herbivorous types, yet they agree with each other, and differ from the analogous Placental Mammalia in having four instead of three true molars, i.e. four molars which are not displaced and succeeded by others, in the vertical direction.

Marsupials never have more than three premolars. In the locomotive organs it is true that we see some of the Marsupials having a hinder thumb, like the Placental Quadrumana; others are digitigrade, with falculate claws, like the Placental Feræ; a third, as the wombat, has the feet adapted for burrowing; a fourth, like the Cheironectes, is aquatic, and has webbed feet; yet all these Marsupials agree with each other in having a rotatory movement of the hind foot, analogous to the pronation and supination, which, in the placental quadrupeds, are limited, when enjoyed at all, to the fore feet; and they manifest, moreover, a peculiar modification of the muscles of the hind leg and foot, in relation to these rotatory movements. In those Marsupials, as the kangaroos, potoroos, and perameles, in which the offices of support and locomotion are devolved exclusively or in great part upon the hind legs, these are strengthened at the expense of the loss of the rotatory movements of the feet; but in the enormous developement of the two outer toes, and the conversion of the two inner ones into unguiculate appendages, useful only in cleansing the fur, these Marsupials differ from all Placentals, whilst the same peculiar condition of the toes may be traced through the Pedimanous group of Marsupials. Thus the locomotive organs, notwithstanding their adaptation to different kinds of progression, testify to the unity of the marsupial group in the two remarkable peculiarities of structure above cited.

The vascular system gives evidence to the same effect. All the Marsupials present the following peculiarities in the structure of the heart; viz. the right auricle manifests no trace of either *fossa ovalis* or *annulus ovalis*, and receives the two *venæ cavæ superiores* by two separate inlets. This generalisation is, however, less urgent in the present question than the preceding, because the modification as regards the separate entry of the superior *venæ cavæ* obtains in a few placental species, as the elephant and certain Rodents; but as the first cited cardiac character is common and peculiar to the Marsupial Mammalia, and as the second, while it is universal in the Marsupials, occurs only as an exceptional condition in the placental series, the arguments which they afford to the unity of the marsupial group cannot be overlooked in a philosophical consideration of the affinities of the Mammalia.

With respect to the nervous system, it has been shown that, in the structure of the brain, the Marsupialia as well as the Monotremata exhibit a close correspondence with the Ovipara in the rudimental state of the *corpus callosum*; the difference which the most closely analogous placental species offer in this respect is broadly marked. (Owen 'On the Brain of the Marsupial Animals,' *Phil. Trans.* 1837, p. 89, pl. vi.)

These coincidences in the Marsupialia of important organic modifications of the dental, locomotive, vascular, cerebral, and reproductive systems, establish the fact that they constitute a natural group, inferior on the whole in organisation to the Placental Mammalia.

The following is a tabular view of the subordinate divisions of the Marsupialia regarded as an order of the Lyencephalous or Implacental subclass of Mammalia:—

Classification of the Marsupialia.

Tribes	Families	Genera	Subgenera
SARCOPHAGA.			
		Thylacoleo . . Plagiaulax . . Microlestes . .	Fossil.
Three kinds of teeth; canines long in both jaws; a simple stomach; no *intestinum cæcum.*	*Dasyuridæ* . .	Thylacinus. Dasyurus. Phascogale.	
Extinct transitional forms		Phascolotherium Amphitherium ? Triconodon. .	Fossil.
ENTOMOPHAGA. Three kinds of teeth in both jaws; a simple stomach; a moderately long *intestinum cæcum.*	*Ambulatoria* .	Myrmecobius.	
	Saltatoria . .	Chœropus. Perameles.	
	Scansoria . .	Didelphys.	Didelphys. Cheironectes.
SARCOPHAGA.			
		Galethylax . . Peratherium .	Fossil.
Anterior incisors large and long in both jaws; canines inconstant; stomach simple, or with a special gland; a very long *intestinum cæcum.*	*Phalangistidæ* .	Phalangista . .	Cuscus. Pseudocheirus. Tapoa.
		Petaurus . . .	Petaurista. Belidia. Acrobata.
	Phascolarctidæ .	Phascolarctus.	
POEPHAGA. Anterior incisors large and long in both jaws; canines present in the upper jaw only, or wanting; a complex stomach; a long *intestinum cæcum.*	*Macropodidæ* .	Hypsiprymnus. Macropus.	
RHIZOPHAGA. Two scalpriform incisors in both jaws; no canines; stomach with a special gland; *cæcum* short, wide, with a vermiform appendage.	*Phascolomyidæ* .	Phascolomys. Diprotodon . Nototherium.	Fossil.

With the exception of one genus, *Didelphys*, which is American, and another genus, *Cuscus*, which is Malayan, all the known existing Marsupials belong to Australia, Tasmania, and New Guinea.

Martello Towers. The name given to the circular buildings of masonry erected along different parts of the British coasts at the commencement of the present century, as a defence against the meditated invasion of Napoleon. The name is usually supposed to be derived from a fort in Mortella (Myrtle) Bay, Corsica, which, after a determined resistance, was at last captured by the British in 1794. These towers are provided with vaulted roofs, and consist of two stories—the lower for the reception of stores; the upper, which is shell-proof, for the casement of troops; and the wall of the building terminates in a parapet, extended to secure the men in working the guns. These are mounted on traversing platforms, so as to be fired in any direction. In many places of England these towers were dismantled, but lately several of them have received a new and more powerful armament.

Marten (Lat. martes). A genus of digitigrade carnivorous Mammalia, of which the common and pine martens (*M. foina* and *abietum*) and the sable (*M. zibellina*) form well-known examples; their fur is an important article of commerce in the Russian empire.

Martial Ethiops. An old Pharmaceutical name of black oxide of iron.

Martial Regulus. Metallic antimony, obtained by decomposing sulphide of antimony by means of iron.

Martin. [Hirundo.]

Martin's Shells. In Artillery, cast-iron spherical shells, lined with a coating of loam and cow-hair, and filled with molten iron. Upon the shell striking a vessel, it is broken by the impact of the molten metal.

Martinet. A cant phrase for a severe military disciplinarian; probably derived from a certain Colonel Martinet, who served in the French army under Louis XIV., who was the inventor of a peculiar whip, called by his name, for the purpose of military punishment.

Martinet. The name of one of the engines of war of the middle ages, probably very similar to the trebuchet.

Martingale. In Naval affairs, a rope leading downwards from the jib-boom end, to keep the jib-boom down against the force of the sail and stay.

In the Manége, the term *martingale* is applied to a thong of leather fastened at the end of the girths under the belly of a horse, and at the other end to the musrol, passing between the legs to keep him from rearing.

Martite. A variety of peroxide of iron, found in iron-black octahedral crystals on the Puy-de-Dôme in Auvergne.

Martlet. In Heraldry, a fanciful bird, shaped liked a martin or swallow, but depicted with short tufts of feathers in the place of legs. It is the difference or distinction of a fourth son.

Martnets. Small ropes attached to the leeches of sails to facilitate furling.

Martyr (Gr. μάρτυς, μάρτυρος, *witness*). When the members of the Christian church were subjected to persecution under the Roman emperors, the persons accused were questioned as to their belief; and, in undergoing punishments and death, were said to bear witness (μαρτυρία) of their Master before the world. A distinction was also made between those who, as boldly asserting their belief, yet not being visited with extreme punishment, were called *confessors*, and those who by suffering death were said to obtain the crown of martyrdom; and thus the term *martyr*, in its ordinary signification, denotes a person who suffers death or persecution on account of his belief.

Martyrology (Gr. μάρτυς, and λόγος). The name given to that department of ecclesiastical history which relates to the acts and death of martyrs. It also signifies a calendar or register kept in religious houses, wherein were inserted the names and donations of their benefactors, and the days of their death. As specimens of this species of works, we may mention the celebrated *Martyrology* of Eusebius, now lost; and Fox's *Book of Martyrs*, the record of the sufferings of the English reformers. Many of the accounts in the early martyrologies are purely fabulous. (Ruinart's *Acta Martyrum*; Baronii, *Martyrologium Romanum*; Middleton's *Free Inquiry*.) Gallonius' *De Sanctorum Martyrum Cruciatibus* is a book which has had great popularity on the Continent.

Maruts. [Thor.]

Mascagnin. A native hydrous sulphate of ammonia, found in the fissures of the lavas of Etna, Vesuvius, and the Lipari Isles. Named after its discoverer, Professor Mascagni.

Mascle. In Heraldry, a bearing in the form of a lozenge perforated; supposed to represent the meshes of a net.

Masked Battery. In Artillery, a battery concealed from the enemy's view.

Masonry (Fr. maçonnerie). The science of combining and joining stones for the formation of walls, and other parts, in the construction of buildings. The science when applied to the construction of domes, groins, and circular arches, is difficult and complicated, depending upon a thorough knowledge of descriptive geometry. Hence the explanation of the various methods of obtaining the requisite lines for the artificer would require an amount of space and a number of diagrams that cannot here be devoted to the subject; but the reader who may desire to become acquainted with this branch of the subject is referred to Rondelet, *Traité Théorique et Pratique de l'Art de Bâtir* (Paris 1829 and 1830, 4to.). Vitruvius mentions several kinds of masonry among the ancients, which were distinguished from each other by the different methods of arranging the stones. The principal are: 1. The *reticulatum*, which

is arranged in diagonal courses, like the meshes of a net; whence its name. 2. The *incertum*, wherein the rising courses are so laid, without any certain sizes of the stones, as that the vertical joint above always falls over the middle of the joint below; the appearance of this work is not so pleasing as that of the first, but the work itself is stronger. 3. The *isodomum*, in which all the courses are of equal height, as its name imports. 4. The *pseudisodomum*, which received its name from the courses being unequal in height. 5. The *emplectum*, in which the faces of the work were wrought, and the centre of the wall filled up with rubble work, in which species of masonry the Greeks employed *diatoni*, or bond stones, running in one piece through the thickness of the wall to tie it together. The first principles to be attended to in building stone walls are, that the vertical joints in any course should not fall over the vertical joints of the course immediately below it; and that where the thickness of the wall consists of two or more pieces of stone, bond stones, or blocks which run through the whole wall transversally, if possible in one piece, should be introduced as frequently as possible for the purpose of binding the whole mass together. The different species of masonry now in use may be reduced to five: 1. Bond masonry, *la pierre de taille*, wherein the stones of each succeeding course are laid so that the joint that mounts and separates two stones always falls directly over the middle of the stone below. 2. Coursed masonry, called by the French masons *moëllon smillé*, in which the rubble masonry is inserted in joints whose bond is carefully broken, and which has all the courses of the same height. 3. Rubble masonry, known by the French masons as the ordinary *moëllon* masonry, which consists of rubble masonry, of small dimensions, laid without much reference to bond. 4. The masonry known on the Continent by the name of *maçonnerie de libage*, which consists in the employment of large stones also, without regard to bond, in the horizontal direction at least. 5. The masonry of *brickwork*, where the bodies and projections of stone enclose square panels or spaces formed of brick.

Masora. A critical work among the Jews, containing remarks on the verses, words, letters, and vowel-points of the Hebrew text of the Bible. As the sacred books were originally written without any breaks or divisions into chapters or verses or even words, the Jews found it necessary to establish a canon to fix and ascertain the reading of the Hebrew text. This rule or canon is designated *Masora*, or tradition, in which the verses, letters, words, &c. are all numbered; and by this means the slightest variations can be detected. The Jewish rabbis who drew up this work are styled Masorites. [BIBLICAL HISTORY, &c.]

Masque or ⁻ ⁻ (a word of doubtful origin). A species of drama, which originated from the custom (in processions and other solemn occasions) of introducing personages in masks to represent imaginary characters. Many of these characters, even in the religious shows of Italy, &c., were of a grotesque description, and the performance was often intermixed with dancing and buffoonery. By degrees, in ⁻ land, something of a dramatic character was added to these exhibitions. At first, as in the well-known progresses of Queen Elizabeth, monologues or dialogues in verse were put into the mouths of the masked performers; and in the reign of James I. they had ripened into regular dramatic performances: sometimes, as in the *Tempest* of Shakspeare, introduced by way of interlude in regular plays; at other times acted as separate pieces, with much machinery and decoration. Ben Jonson was the first, and indeed almost the only, classical English writer (with the exception of Milton, in the solitary and noble specimen of *Comus*) who devoted much labour and taste to this department of the drama. His masques were represented at court: the queen of James I., and after her the accomplished Henrietta Maria, did not disdain to take part, at least as silent dramatis personæ, in some of these pageants. The taste for them died away in the reign of Charles I.; and after the interruption given to the progress of dramatic art and literature by the civil wars, they were not again brought into fashion.

Masquerade. An amusement practised in almost every civilised country of modern times, consisting of a ball and other festivities, in which only those who are masked or disguised can participate. This species of amusement had its origin in Italy, where, according to Hall's *Chronicle*, they had become fashionable so early as in the beginning of the sixteenth century. Of its introduction into England, Hall thus speaks: 'On the date of the Epiphaine, at night (A.D. 1512-13), the king (Henry VIII.) with eleven others were disguised after the manner of Italie, called a maske, a thing not seen afore in England; they were apareled in garmentes long and brode, wrought all with golde, with visers and cappes of golde; and after the banket doen, these maskers came in with the six gentlemen disguised in silk' (in all probability the *domino* of more recent times), 'barynge staffe torches, and desired the ladies to daunce: some were content; and some that knew the fashion of it refused, because it was not a thing commonly seen. And after thei daunced and commoned together, as the fashion of the maskes is, thei toke their leave and departed, and so did the quene and all the ladies.' The invention of masquerades is ascribed to Granacci, who died in 1543.

Mass (Low Lat. missa). The name by which Roman Catholics designate the celebration of the Lord's Supper after the forms of the Roman church. The term is commonly derived from the phrase, 'Ite, missa est concio' (i.e. *Go, the assembly is dissolved*); by which the priest, in the primitive ages, signified to the catechumens that all that part of the service of the church was concluded which it was allowed to all

believers indiscriminately to attend. This derivation has, however, been questioned by Mr. King, in his work on *The Gnostics and their Remains*. The communion of the eucharist was extended only to the higher class, the *fideles*, who had completed the period of initiation and instruction; and after the pronunciation of these words, the offering of the body and blood was made. It was to this offering itself that the term *missa* came to be applied. The service of the mass, as it is still retained throughout Catholic countries, was the work of Gregory I. in the sixth century. It consists of three parts: the offertorium, or offering of the elements upon the altar; the consecration, by which they are supposed to undergo the transubstantiation into the real body and blood of Christ; and the sumption, or actual participation in them by the communicants. These ceremonies are accompanied by the recitation of various prayers; and the priests go through numerous evolutions, which are supposed to represent the circumstances attending the Passion. High mass is the performance of this service accompanied with music.

MASS. In the Fine Arts, a large quantity of matter of light or shade. It is generally applied in painting to light and shade brought upon objects proper for their reception, and grouped or arranged so as to give repose and pleasing variety both of one and the other without being scattered.

MASS (Lat. massa, Ger. masse). In Mechanics, this term is synonymous with *quantity of matter*. At the same distance from the earth's centre, *mass is directly proportional to weight*, since we must assume that the force of gravity then acts equally on all equal particles of matter. At different distances from the earth's centre, however, weight varies whilst mass remains unaltered, so that we must regard *weight* as the *product of mass into the force of gravity*. The mass of a homogeneous body is proportional to its volume; and the mass of the unit of volume being termed its density, we may define mass as the product of volume and density.

Masseter (Gr. *μασητήρ, a chewer*). A short thick muscle which raises the lower jaw, and assists in moving it backwards and forwards in the act of chewing.

Massicot. Yellow oxide of *lead*.

Mast (Ger.; Fr. mât). A long piece or system of pieces of timber, placed nearly perpendicularly to the keelson of a vessel to support the yards or gaffs on which the sails are extended. When a mast is one entire piece, it is called a *pole-mast*; but in all large vessels it is composed of several lengths, called *lower*, *top*, and *top-gallant* masts—sometimes a fourth, called a *royal* mast, which, however, is usually in one piece with the top-gallant mast.

The method of supporting each mast on the one next below it is peculiar. On the sides of the lower mast, some feet below the head, are placed cheeks: on these are fixed horizontally two short pieces of wood, fore and aft, called *trestle trees*. Across these at right angles are laid, before and abaft the mast, two or more longer and lighter pieces, called *cross trees*, which give the name to the entire system. On the masthead itself is a *cap*.

The topmast, being placed up and down the fore side of the lower mast, is *swayed up* between the trestle trees, and through the round or foremost hole in the cap, by means of the lifts. When raised so high that the *heel* of the topmast is just above the surface of the cross trees, a piece of iron, called the *mast-fid*, is put through a hole formed in the heel for that purpose; and on this fid, of which the ends are supported on the trestle trees, the topmast rests. When fidded, the topmast is *stayed*, and the rigging or shrouds *set up* to the *dead eyes* in the ends of the cross trees or top. These dead eyes pull from the lower rigging below, and thus the cross trees of the top serve merely to extend the rigging of the topmast. The topgallant is supported in the same manner on the topmast, its shrouds passing through holes in the ends of the topmast cross trees down to the top below. When the mast is to be taken down, it is first raised to relieve the fid; which being drawn out, the mast is lowered.

The masts are supported by a strong rope, leading forward, called the *stay*; by others, leading aft on each side of the ship, called, in general, *backstays*; and by others abreast, called *shrouds*.

Large lower masts are composed of several pieces, about a foot square, with rounded segmental lengths on the outside, and the whole encircled at intervals by hoops. Hollow masts of iron are likewise now successfully employed; being considered not less strong than wood, and much lighter.

The *main-mast* is near the middle of the vessel, if there be three masts, otherwise at the after part. The *fore-mast* is that which is nearest the fore part, and the *mizen-mast* is abaft the mainmast.

The old rule for the length of the main lower mast is to take $\frac{1}{2}$ the sum of the length of the lower deck and extreme breadth: the fore-mast is $\frac{8}{9}$ths of the main-mast, the mizen-mast considerably smaller. The topmast is about $\frac{3}{5}$ths of the lower mast. These rules, as well as others for the thicknesses, &c., are merely for convenience, based on no mechanical principle, and are by no means strictly followed.

Master (Lat. magister). A title frequent among the Romans: as magister equitum (master of the horse, the lieutenant or second in command to a dictator), magister bibendi, &c. Magister militum (master of the soldiers, or of military affairs) was a title under the later Roman emperors. *Grand master*, in modern times, is the common title of the chief of the orders of knighthood, and of some fraternities, as the Freemasons. The eldest sons of some noble landed proprietors are designated as masters in Scotland; as the master of Gray, master of Douglas, &c.

MASTER. In the Universities, a degree in arts; the most ancient of all the academical titles. In the university of Paris, where this, as

well as the other learned distinctions, appears to have originated, it was originally a mere title, belonging to those who taught in the schools (magistri, doctores). Thus every master was, of necessity, a lecturer. In process of time (and probably about the middle of the thirteenth century the title became a degree, attainable by all after a certain amount of residence and proficiency; while the duty of lecturing was confined only to a certain number of masters, termed *regents*. About the same period the separation of the degrees of master and doctor took place. In the English universities, the degree of master of arts follows that of bachelor, and is the highest in the faculty of arts, which is subordinate to that of divinity. Elsewhere the faculty of arts is synonymous with that of philosophy, in which the degree of doctorate is conferred, superior to that of master.

MASTER, otherwise called CAPTAIN. In Commercial Navigation, the person intrusted with the care and navigation of a ship. His duties are very important. In some countries no one can be appointed to this office who has not been declared fit to fill it by a legally constituted board; but in this country the owners, except in the case of large vessels, are left to their own discretion as to the skill and honesty of the master; and although he is bound to make good any damage that may happen to the ship and cargo by his negligence or unskilfulness, he cannot be punished as a criminal for mere incompetence. Under the Mercantile Marine Act, however, the Board of Trade grants certificates of qualification to masters of vessels, and possesses the power of withdrawing them in case of a want of skill being evinced. Large vessels may only be commanded by certificated masters, and even in small vessels the certificated man naturally has the preference.

MASTER. In the Royal Navy, the officer who has the charge of the navigation of the ship, with other duties: he ranks with, but after, a lieutenant. On completing certain long service the master becomes staff-commander and staff-captain, ranking similarly with commander and captain. The class of masters is gradually dying out, their place being intended to be hereafter taken by *navigating lieutenants*, i.e. lieutenants who have passed a special examination in the art of navigation.

Master Attendant. The officer next in rank to the superintendent of a royal dockyard, and usually a commander in the navy.

Master of the Ceremonies. An officer attached to all European courts, whose duty consists in regulating all matters of etiquette and state ceremony. [CEREMONIES, &c.] The name is also applied to anyone appointed by general consent to preside over the arrangements of a public ball.

Master Gunner. A warrant officer, selected from the non-commissioned officers of artillery, whose duty is to take charge of guns, ammunition stores, &c. in fortresses.

Master of the Horse. The third great officer in the British court. [HOUSEHOLD.]

Master of the Household. An officer employed under the treasurer of the household to survey accounts.

Master of the Robes. An officer of the royal household, in the lord chamberlain's department.

Master of the Rolls. [CHANCERY.]

Master Singers. A class of poets in Germany during the fifteenth and part of the sixteenth century. They were confined to a few imperial towns, and their chief seat was the city of Nuremberg. They were generally of burgher extraction; and formed regular corporations, into which proficients were admitted by the ordinary course of apprenticeship. Their poetry (generally confined to devotional or scriptural pieces, legendary tales, with some admixture of satire and of amatory lyrics) was subjected to a peculiar and pedantic code of laws; and a board of judges (styled *merker*) assembled to hear the poems recited, and *mark* the faults which might be committed in either particular: he who had the fewest faults received the prize. Hans Sachs, the famous cobbler of Nuremberg, was a member of these societies; although his genius was of too independent a character to submit to the trammels of their poetical regulations.

Masters. In the Superior Courts of Law and Equity in England, subordinate officers of those courts, whose duties chiefly relate to the taxation of costs and decision of minor questions between suitors. The *masters in ordinary*, commonly called *masters in chancery*, whose functions were of a more important character, were abolished in 1853 (15 & 16 Vict. c. 80).

Masters in Chancery. [MASTERS.]

Master-at-Arms. A petty officer of the navy, who is the head of the police of the ship: his assistants are called ship's corporals.

Masterwort. *Imperatoria Ostruthium.*

Mastic. A resin which exudes from the *Pistacia Lentiscus.* Its chief use is in varnishes. It is often erroneously called *gum-mastic.*

Masticatories. Medicines which tend to increase the flow of saliva. [SIALOGOGUES.]

Masticin. That part of mastic which is insoluble in alcohol; it has some of the characters of caoutchouc. The part of mastic soluble in alcohol has been termed *Masticic acid.*

Mastitis (Gr. μαστός, *the breast*). Inflammation of the breast in women; it commonly terminates in suppuration.

Mastodon (Gr. μαστός, and ὀδούς, *tooth*). A genus of extinct fossil quadrupeds allied to the elephant; so called from the conical projections upon the surfaces of the molar teeth. It is divided by Dr. Falconer into the sections Trilophodon and Tetralophodon.

Mastoid Processes (Gr. μαστοειδής). Certain *nipple-like* protuberances of the bones.

Mastotheca (Gr. μαστός, and θήκη, *a receptacle*). A name sometimes applied to the abdominal pouch of the marsupial animals.

Matador (Span. *a slayer*). The name given to the man whose office it is to give the deathblow to the bulls wounded in the Spanish bullfights.

Match (a word of doubtful origin). In Gunnery, a material employed in firing mines, &c. Before the invention of locks, small arms were fired by means of match. *Slow match* consists merely of hempen rope loosely twisted and dipped in a solution of saltpetre and lime-water. It burns at the rate of one yard in three hours. *Quick match* is merely cotton coated with a composition of mealed powder, gum, and water. When not confined, it burns at the rate of one yard in thirteen seconds. [Lucifer.]

Match Boarding. This term is applied to wall linings executed in boarding beaded on the edge, and with a groove in the plank that carries the bead and a tongue on the edge of that which follows it. Sometimes this style of work is called *matched* and *beaded boarding*; sometimes the beading on the edge is dispensed with, and the boarding presents joints that are simply mortise-joints.

Matchlock. A hand firearm, the charge of powder in which is lighted by means of Match.

Mate (Dutch maet, Old High Ger. gámazi). In a Merchant Ship, the deputy of the master, taking in his absence the command. There are sometimes only one, and sometimes two, three, or four mates in a merchantman, according to her size, denominated *first*, *second*, *third*, &c. mates. The law, however, recognises only two descriptions of persons in a merchantman—the master and mariners, the mates being included in the latter, and the captain being responsible for their proceedings.

In the Royal Navy, the term *mate* is now limited to the assistants of certain warrant officers, as boatswain's mate, gunner's mate, &c. Formerly it was the distinctive title of the next grade to lieutenant, now called sub-lieutenant. There were also the master's mate, now second master; and surgeon's mate, now assistant-surgeon.

Matè. The South American name of the *Ilex paraguayensis*, a species distinguishable by its smooth ovate-lanceolate, unequally-serrated leaves, by much-branched racemes of flowers, the subdivisions of which are somewhat umbellate, and by the slightly hairy calyx of its flowers. The Matè is of the same importance in the domestic economy of South America as the Chinese tea is in that of this country, and it is calculated that its consumption in that continent amounts to about 8,000,000 lbs. annually. It has been in use for about a century and a half, the practice having been adopted from the aboriginal people. The leaves are prepared by drying and roasting—not in the manner of Chinese teas; but large branches are cut off the plants and placed on hurdles over a wood fire until sufficiently roasted; the branches are then placed on a hard floor and beaten with sticks; the dried leaves are thus knocked off and reduced to a powder, which is collected, and made into packages, ready for use. There are three sorts known in the South American markets—the Caa-Cuys, which consists of the half-expanded leaf-buds; the Caa-Miri, the leaf torn from its midrib and veins, without roasting; and the Caa-Guaza or Yerva de Palos of the Spaniards, the whole leaf with the petioles and small branches roasted.

Matè is prepared for drinking by putting a small quantity, about a teaspoonful, into a gourd or cup, with sugar; the drinking tube is then inserted, and boiling water poured on; when sufficiently cool, the infusion is sucked up through the tube. It has an agreeable slightly aromatic odour, is rather bitter and restorative, and very refreshing. It acts as a slight aperient and diuretic, and if too largely indulged in, debilitates the nervous system. It contains the active principle—theine—of tea and coffee.

Materia Hermaphrodita. A term applied by Boerhaave to a peculiar substance soluble both in alcohol and water, and contained in vegetable extracts. Scheele called it *Materia saponacea*. It is the *extractive* or *humine* of later chemists.

Materia Medica (Lat.). This term embraces the various substances, natural and artificial, which are used in the cure of disease, and which are usually called *medicines*. They are frequently arranged into classes dependent upon their virtues or effects, or upon their constituent parts; but perhaps the most convenient arrangement is the alphabetical.

Material, Raw or Rude. In Political Economy, a term used to imply such products of human labour as require further manipulation in order to make them available for use or consumption. In the progress of a nation towards opulence larger quantities of raw material are imported, in order that they may receive the finish of manufacture. Thus, this country purchases silk from Italy and China, wool from Australia, alpaca from Eastern South America, cotton from all parts of the world, hemp and flax from Russia, and exports goods manufactured from these materials. The term appears to have been originally employed by Adam Smith.

Materialism. That metaphysical theory which is founded on the hypothesis that all existence may be resolved into a modification of matter, including, of course, the conscious subject. The most celebrated materialists were, among the ancients, Democritus and his later disciples, Epicurus and his sect, to whom may be added, though in a somewhat different sense, the Stoics; among the moderns, Gassendi, Hobbes, Hartley, and Priestley. Most schemes of materialism rest on the assumption that all that is real in nature consists in the minute particles from the juxtaposition of which all sensible objects arise. This is what is variously designated as the *atomic*, the *mechanical*, or the *mechanico-corpuscular* theory, and has met with supporters chiefly in France.

Among ourselves, in very recent times, Dr. Thomas Brown maintained that part of this system which relates to physical phenomena, though he has combated, with great subtlety and ingenuity, the portion of it which includes the nature of the mind itself. (Compare secs. v.–ix. with secs. xii.–xiv. See also Priestley's *Disquisitions on Matter and Spirit*, 1777; and his *Three Dissertations on the Doctrine of Materialism and Philosophical Necessity*; also Price's *Letters on Materialism and Philosophical Necessity.*) Since that period, the term *materialism* seems itself to have fallen into disfavour, although the doctrines of the Encyclopedic school of philosophers in France (Cabanis, Condillac, and others), of similar tendency, still find their supporters in various altered forms. [METAPHYSICS.]

Mathematici. [GENETHLIACI.]

Mathematics (Gr. μαθηματικός, from μάθημα, *a lesson*). The science which investigates the properties of number and space. It is sometimes divided into *pure* and *mixed* or *applied mathematics.* The distinction, however, is vague and useless. Whenever, according to it, the properties of matter enter into consideration, as in mechanics, mathematics become *mixed.* The principal branches of pure mathematics are arithmetic, algebra, geometry (pure and algebraic), differential and integral calculus, calculus of differences, of functions, of variations, of operations, and of probabilities.

Matico (its name in Peru). The dried leaves of *Artanthe elongata* of some botanists, *Piper angustifolium* of others, imported from Peru; they are from two to eight inches long, veined and tesselated on the upper surface, downy beneath, with an aromatic astringent taste, and an agreeable odour. They contain an essential oil, and a bitter principle which has been called *maticin*, and are tonic and stimulant.

Matins. In the Roman Catholic church, the earliest of the canonical hours of prayer. [HOURS.]

Matlockite. An oxy-chloride of lead, found in an old mine at Matlock in Derbyshire.

Matrass. A chemical vessel employed in sublimations, and in digesting solutions in a sand heat. It is superseded in the modern laboratory by a flask.

Matriculation (from Lat. mater, *mother*). This word is used in universities on the old model to express the act of admitting a member. Matriculation, in the English universities, is contemporary with admission into one of the colleges or halls of which the university is composed.

Matrix. Any rectangular arrangement of symbols.

Thus

$$\begin{matrix} a_1 & b_1 & c_1 & d_1 \\ a_2 & b_2 & c_2 & d_2 \\ a_3 & b_3 & c_3 & d_3 \end{matrix}$$

is a rectangular matrix consisting of four *columns* and three *lines* or *rows.* When there are an equal number of rows and columns the matrix is said to be *square*, and that number expresses the order of the matrix. In all cases the symbols, which may denote either quantities or operations, are called the *constituents* of the matrix, and in a square matrix the line joining the upper left to the lower right hand corner is called the *principal diagonal* of the matrix, the constituents situated upon it being distinguished as *principal constituents.* Any two constituents of a square matrix which are symmetrically placed with respect to the principal diagonal are said to be *conjugate.*

The *inverse* or *reciprocal* of a given square matrix is a matrix, of the same order, whose constituents are, respectively, the coefficients of the corresponding constituents in the determinant formed from the given matrix. [DETERMINANT.] The constituents of the reciprocal matrix, therefore, are the several first minors of the determinant in question, and are consequently themselves determinants of the next lower order.

A square matrix is said to be *symmetrical* when the conjugate constituents are equal; if besides this the constituents are all equal which are situated in the diagonal bands transverse to the axis of symmetry, the matrix is said to be *persymmetrical.* An ordinary addition table is an example of such a matrix.

MATRIX. In Metallurgy, the stony substance in which crystalline minerals and metals are embedded is frequently termed their *matrix* or *gangue.*

In Die-sinking, the *matrix* is the indented engraving or mould from which impressions are taken in relief.

Type-founders apply the term *matrix* to the iron moulds in which the letters are cast.

Matter (Lat. materies). Substance. That part of the universe which is neither mind nor force. We know nothing of the essential or intimate nature of matter, and are only acquainted with its existence through its *sensible properties.* The following are generally considered as the essential properties of matter:—

1. *Divisibility*, or the property which every known substance possesses of being separable into parts, and these again into smaller parts, and so on until the parts become inappreciable to our senses. Although no definite limit can be assigned to this subdivision, there is reason to believe that matter is not infinitely divisible, but that each kind of matter consists of ultimate particles or atoms, or groups of such atoms, which are incapable of being further subdivided.

2. *Impenetrability*, or a resistance exerted by every body to the occupation of its place by another. No two bodies can simultaneously occupy the same place.

3. *Porosity*, or the separation of the particles or atoms from each other by intervals or pores. Every substance with which we are acquainted is more or less porous.

4. *Compressibility*, or the property in virtue

of which the volume of every body may be contracted into smaller dimensions.

Among the essential properties of matter may also be included *extension* and *figure*; but these belong also to space, and form the subject of geometry.

The contingent properties of matter are *mobility* and *weight*. Matter in every form is capable of being moved from one place to another; and every substance is subject to the attraction of gravitation. But motion has reference to space, and weight to the attraction of other matter.

The above are the general properties of matter, upon which physical investigations depend. There are, however, various other qualities belonging to particular substances, or to matter in particular states, the consideration of which is important in mechanical philosophy. Among these the principal are Elasticity, Fluidity, Hardness, Rigidity, Solidity, for which see the respective terms.

Matura Diamond. A kind of Zircon used by the native jewellers of Ceylon, by whom the pink stones are sold for rubies.

Mauilite. A variety of Labrador Felspar, found in Maui, one of the Sandwich Islands.

Maundy Thursday. The Thursday preceding Easter, on which the sovereign of England distributes alms to a certain number of poor persons at Whitehall; so named, perhaps, from the maunds or baskets in which the gifts were formerly contained. This custom is of very great antiquity; and according to Ducange it derives its origin from St. Augustine. Maundy Thursday is also called Shere Thursday. (Nares' *Glossary*; Fosbrooke's *Encyc. of Antiquities*, p. 702.)

Maur, St., Congregation of. A learned body of religious of the Benedictine order; so called from a village near Paris, where they were established in 1618. On the request of Louis XIII., Gregory XV. gave this order his approval by an apostolical brief, dated 17th of May, 1621; and it obtained new privileges from Urban VIII., by a bull dated January 21, 1627. The fame of this body attracted the attention of many other religious orders, several of which were induced to submit to its rules; and at last it numbered upwards of a hundred religious houses. The literary world owes to them a series of very valuable editions of ancient Greek authors, chiefly fathers, during the seventeenth century. Among the most eminent of its members during that period may be mentioned Jean Mabillon, Thierri Ruinart, Hugh Menard, and Bernard de Montfaucon.

Mausoleum (Lat.). A sepulchral building erected to the memory of some celebrated character, so called from Mausolus, king of Caria, to whose memory a monument of this character was raised by his wife, Artemisia, about the year 353 B.C., whence all sepulchral monuments of importance have obtained the name of mausolæa. From its magnificence this monument was reckoned one of the seven wonders of the world. It has lately been the object of the care of the British government, who have sent an expedition, under the direction of Mr. Newton, for the purpose of rescuing the relics of it from the ravages of time and the carelessness of the inhabitants of the country; the marbles from it are at present in the British Museum, and they confirm the reports of the ancients as to the beauty and skill of the monument. According to Pliny, it was one hundred and eleven feet in circumference, and one hundred and forty feet high; it is said to have been encompassed by thirty-six columns, and to have been profusely adorned with sculpture. (*Edinburgh Review*, Oct. 1862, p. 461 &c.)

Mauve (from Lat. malva, *a mallow*, the petals of which have purple markings). A purple dye obtained from aniline and from benzol, two of the constituents of coal-tar. This colouring matter was discovered in 1861 by Mr. Perkin, and is made by oxidising aniline with chromic acid. Heated together, sulphate of aniline and bichromate of potash yield a precipitate which is crude mauve. this be dissolved in alcohol and the solution evaporated, the pure dye is obtained. Silk and wool readily take up mauve dye, while cotton and calicoes require mordanting with tannin or a basic lead salt.

Maxilla (Lat. *a jaw*). In Anatomy, this term is applied to the bones supporting the teeth of both jaws. In Zoology, it is restricted to the upper jaw in Mammalia, and to the inferior pair of horizontal jaws in articulate animals.

Maxima and Minima. In Mathematics, a variable quantity or function is said to be a maximum or minimum when its numerical value is greater or less than any immediately adjacent values, that is to say when the smallest change in the values of one or more of the independent variables causes a diminution or augmentation in the value of the function. Thus a function may have several maxima or minima; the greatest of the former is called a *maximum maximorum*, and the least of the latter a *minimum minimorum*. The determination of maxima and minima is fully explained in all good treatises on the differential calculus and the calculus of variations. The methods to be pursued vary, of course, with the nature of the function to be investigated, and in some cases questions of a peculiarly delicate nature present themselves for solution. We must here limit ourselves to the simplest and most frequently occurring case, where the maxima and minima of an explicit function, y, of a single independent variable, x, are required. To determine these it is necessary to ascertain, in the first place, what values of x cause $\frac{dy}{dx}$ to change sign, by passing through 0 or ∞. This done, the effect of each such *critical value* of x upon the differential coefficients of higher order must be examined. If the first of these which does not vanish for the critical value under examina-

tion be of an *odd* order, that value will not correspond to either a maximum or minimum of y; if of even order, however, the function y will be a maximum or minimum according as the differential coefficient in question acquires a negative or a positive value.

The purely geometrical methods of determining maxima and minima are of a far less uniform and systematic character; they have the advantage, however, of being more instructive, inasmuch as they reveal more fully the true origin of the maximum or minimum properties under examination. This has been admirably shown by Steiner in his memoirs on maxima and minima in Crelle's *Journal*, vol. xxiv. To illustrate such methods by a very simple example, let it be required to determine from what point M of a given curve (C) the distance between two given fixed points A and B will appear greatest or least. Since the visual angle AMB is *constant* for all points M on the circumference of a circle passing through A and B, and is less for all points without this circle and greater for all points within it, the problem will obviously be solved by determining the points of contact, with the given curve (C), of all circles which pass through the fixed points A and B.

May (Lat. Maius). The fifth month of our year, but the third of the old Roman calendar. [CALENDAR.]

May Apple. *Podophyllum peltatum.* The leaves are poisonous, and the root cathartic, but the fruit is agreeable and esculent. The rhizomes possess active medicinal properties, on account of which the plant has been cultivated.

May Beetle. [MELOLONTHIDANS.]

May Day. The first of May is usually so called in England, by way of eminence, in commemoration of the festivities which from a very early period were till recently, and in many parts of the country are still observed on that day. In looking at the nature of these rites, it is evident that they are akin to the observances practised in honour of the Latin goddess Flora; but it is impossible to fix with accuracy the precise period at which they were introduced into England. At first the observance of this day appears not to have been peculiar to any class of society. In his *Court of Love* Chaucer says, that on this day 'forth goeth all the court, most and least, to fetch the flowres fresh, and braunch and bloom;' and Henry VIII. and Katherine and all their court partook in the diversion. The *maypole*, which is still visible in many of the English villages, and *Jack in the green* are still relics of this custom. (Grimm's *Deutsche Mythologie*, pp. 448–451.)

May-fly. The popular name of the Nemopterous insects, comprising the genus *Ephemera* and its allies. They live in the larval state for about two years under water, or in wet places; but die frequently a few hours after attaining their highest final stage of metamorphosis.

Mayor (Lat. major, meaning the first or senior alderman). The title of the chief municipal officer of a borough, to whom it appears to have been first given by charters granted some time after the Conquest. But the title and office of portreeve or boroughreeve still continued, in some few places to the exclusion of, and in some others in conjunction with, that of mayor, until the passing of the Municipal Reform Bill, 5 & 6 Wm. IV., by which the latter title was applied universally and exclusively to every borough. The chief magistrates of London and Dublin are designated Lord Mayor.

In France, the first municipal officer of each commune, according to a general system established by the law of December 14, 1789, which created municipalities, is styled *maire*. He has one or more *adjuncts* or assessors, according to the population of the commune. The maire keeps the registers of births, marriages, &c. of the commune; he acts as a magistrate in the apprehension and commitment of offenders; he has also a judicial power over certain minor offences. He is also the principal agent of the general administration for his commune, and the executive authority to carry into effect the ordinances of the municipal council. The maire is now named by the emperor, and his office lasts five years.

Mayor of the Palace (Lat. major domus regiæ). In early French History, the title of the chief officer of state under the Merovingian kings. After the death of Dagobert I., A.D. 638, and in the subsequent decay of the royal authority, these functionaries by degrees usurped almost the entire power of the state. The first of those mayors who exercised this kind of sovereignty was Grimoald, under Sigebert III., king of Austrasia. Pepin, son of Charles Martel, having succeeded his father in the office of mayor of the palace, ascended the throne in 752; after which time the office lost its importance, or was altogether abolished. (Turner, *History of England in the Middle Ages*, vol. i. p. 8.)

Mayorazgo (Span. from Lat. magistratus). Strictly, the right possessed by the eldest born in noble families to inherit certain property on condition of transmitting it entire to those possessed of the same right on his decease. Five distinct species of mayorazgo, or right of hereditary succession, are now known in Spanish law. Property held in virtue of the right cannot be alienated or disposed of. The mischievous effects of this strict system of entail on agriculture and national wealth, and on the character of the higher classes of Spain, have been long insisted on by political philosophers. [MAJORAT.]

Mazzinians. In Politics, the extreme party of progress in modern Italy have received this popular appellation, from the name of their most active leader, Joseph Mazzini. This celebrated personage was an advocate in Genoa (his birthplace), when in the year 1830 he became compromised in the revolutionary movements then in progress, was condemned

to death *par contumace*, and fled the country. From that time his name is found mixed up in most, with actual participation in many, of the plots which have been formed for revolutionising Italy. Originally a member of the ancient association of the Carbonari, Mazzini seems to have regarded it as ill adapted for the continuance of the struggle in which it had failed in 1820–30, and to have raised up in its stead the recent societies known as *Young Italy* and *Young Europe*, which conducted their operations under his auspices first from Switzerland and afterwards from England. Republicanism and Italian unity were the two objects, at one time deemed equally chimerical, towards which their operations were directed. The part played by Mazzini himself in the Roman affair of 1848 is well known: since his second exile on that occasion, he is believed to have had comparatively little influence in the course of events.

Mead (Gr. μέθυ, Dutch meede). A vinous liquor made by dissolving one part of honey in three of boiling water, flavouring it with spices, and adding a portion of ground malt and a piece of toast dipped in yeast, and suffering the whole to ferment. The Scandinavian mead is flavoured with primrose blossoms. A liquor called by this name formed the ancient and for centuries the favourite beverage of the northern nations.

Meadow. A flat surface under grass, generally on the banks of a river or lake; but so far above the surface of the water as to be considerably drier than marsh land, and, consequently, to produce grass and herbage of a superior quality. The soil of meadow lands, if the term be confined strictly to river-side pastures, is generally alluvial, and more or less mixed with sand; it is kept in a state of fertility by the depositions made on its surface, in consequence of being occasionally overflowed by the adjoining river or lake. The produce of meadows is generally made into hay, which, though not equal in quality to that produced on drier grass lands, is yet superior to what is obtained from marshes.

Water meadows are such as receive generally during the winter months, though occasionally also in the summer time, the waters of an overflowing stream, which, by a suitable arrangement of the land in alternate ridge and furrow, are made to traverse the surface without stagnating anywhere. The result is a rapid and early growth of grass in spring time, which, though not very nutritious, is useful for cows, ewes, and lambs, at a time when green food is not abundant.

Drainage is as necessary for the attainment of a high degree of fertility in water and other meadows, as it is in the case of ordinary pasture and arable land; and the application of manure is then as desirable and profitable. Mr. Lawes' experiments show that ammoniacal manures, as guano, sulphate of ammonia, &c., tend to the developement of grasses in meadows; and *mineral* manures, as phosphates and the alkalies, tend rather to the developement of the clovers and other leguminous plants.

Mean (Fr. moyen). In Mathematics, a quantity whose value, when determined according to some assigned law, is intermediate between those of two or more given quantities. [Arithmetic; Geometric and Harmonic Mean.]

Mean Distance. The mean distance of a planet from the sun is equal to its semi-axis major. That of the earth is taken as the unit of most measurements connected with our system.

Mean Sun. To obtain a proper measure of time, an imaginary, or as it is called a *mean sun* is supposed to move uniformly in the celestial equator with the mean velocity of the true sun. A *mean solar day* is the interval between two successive transits of the mean sun over the same meridian. It begins when the mean sun is on the meridian.

Measles (Dutch maeslen, from maese, *a spot*). A fever accompanied with eruptions. It occurs chiefly in early youth, and is for the most part a trivial malady. The nose and eyes generally become inflamed, and watery discharge follows. The principal danger consists in the occasional complication with inflammation of the lungs (pneumonia). The eruption is of peculiar character, the marks upon the skin having an irregular crescentic form. Measles appear to occur occasionally as an epidemic. It rarely affects the system more than once. The treatment of uncomplicated cases is generally limited to the exhibition of mild aperients and diluent drinks. The complications require energetic treatment, modified by considerations of age and habit and the general character of the attack. [Rubeola.]

Measure (Lat. mensura). In Geometry, a magnitude or quantity taken as unit, and employed to express the relations of other magnitudes or quantities of the same kind. Euclid defines the measure of a quantity to be that which, being repeated a certain number of times, becomes equal to the quantity measured. Thus in Arithmetic, the *measure of a number* is any number which divides the given number without leaving a remainder; but this definition rather corresponds to the notion of *aliquot part*.

In a general sense, the term *measure* is applied to that by which anything is compared in respect of quantity. Thus, we have measures of extension, of weight, time, force, resistance, temperature, &c.; in short, of everything of which greater and less can be predicated; and it frequently happens that the unit or measure is not taken in the thing or property which is the immediate subject of consideration, but in something else which depends on it, or is proportional to it. Angular space, for example, is measured by an arc of a circle; time, by the rotation of the earth about its axis, or its revolution about the sun; mechanical force, by the quantity of motion which it imparts to a body; degrees of heat, by the expansion of metals or other substances; muscular strength, by the

resistance of a spring, &c. [ANGLE; CHRONOLOGY; GRAVITY; THERMOMETER; DYNAMOMETER, &c.]

By measure, in an absolute sense, is understood the unit or standard by which we measure extension. We have, therefore, measures of length, of superficies, and of volume or capacity; but, as the two latter may be deduced in all cases from the former, it is only necessary to establish a unit, or standard of length. The choice of such a standard, and the different multiples and parts of it taken for the uses of society, form a metrical system, or system of metrology.

Standards of Measure.—As no precise notion can be formed of the magnitude of a line in any other way than by comparing it with another line of a known length, the necessity of having recourse, for the interchange of ideas, to measures not entirely arbitrary, but fixed by nature, and intelligible alike to all mankind, seems to have been perceived in the earliest ages. Hence originated the *foot*, the *cubit*, the *span*, the *hand*, the *fathom*, the *barleycorn*, the *hair's-breadth*, and other denominations of measure, taken from parts of the human body, or from natural objects, which, though not of an absolute and invariable length, have a certain mean value sufficiently definite to answer all the purposes required in a rude state of society. But, as civilisation advanced, the necessity of adopting more precise standards would be felt, and the inadequacy of such measures as the foot, the cubit, &c. (referred only to the human body) to convey accurate notions, would be rendered most apparent in their application to itinerary measures, or the estimation of great distances; where differences of the fundamental measure, of no account when one or two units only are taken into consideration, would amount, by repeated multiplication, to enormous quantities. In order to avoid this inconvenience, recourse was had to other methods of estimation; but which, in fact, amounted only to descriptions more or less vague, and not to measures. Thus, in ancient authors, we frequently read of a day's journey, a day's sail, and so forth; and in many parts of the continent of Europe, even at the present time, it is the custom of the peasantry to reckon itinerary distances by hours.

On looking among the objects of nature for a standard of measure perfectly definite, and, at the same time, invariable, and accessible to all mankind, a very slender acquaintance with geometry and natural philosophy will suffice to show that the subject is beset with innumerable difficulties. In fact, nature presents only two or three elements which, with the aid of profound science and a refined knowledge of the arts, can be made subservient to the purpose; and none at all which are applicable without such aid. The earth is nearly a solid of revolution, and its form and absolute magnitude are presumed to remain the same in all ages: hence the distance between the equator and the pole is an invariable quantity; and any assigned part of that distance, as the 90th, or a degree of the meridian, is constant, and will furnish a precise and unalterable standard of measures, fit for the purposes of metrology, provided we have the means of comparing it with the rods or scales which must necessarily be used in comparing distances, or the magnitudes of bodies. The force of gravity at the earth's surface is constant at any given place, and very nearly the same at all places under the same parallel of latitude and at the same height above the level of the sea; hence the length of a pendulum which makes a given number of oscillations in a day is also constant at a given place, and, with proper skill and precautions, may be determined in terms of any assumed scale. These two elements, the length of a degree of the meridian, and the length of the seconds' pendulum, are the only ones furnished by nature which have yet been used as the basis of a system of measures. One or two others have been suggested, as the height through which a heavy body falls in a second of time, determined, like the length of the pendulum, by the force of gravity; or the perpendicular height through which a barometer must be carried till the mercurial column sinks a determinate part—for example, a 30th of its own length; but, for reasons which it is unnecessary here to state, these distances are not so susceptible of being accurately determined as the terrestrial degree, or the length of the seconds' pendulum.

English Standard Measures.—The unit of lineal measure in this country is the yard, all other denominations being either multiples or aliquot parts of the yard. But as this is an entirely arbitrary measure, and until the year 1824 was never strictly defined by the legislature, great perplexity has often arisen in attempting to ascertain the exact portion of space which it was meant to represent. For the purpose of preserving some degree of uniformity among the ordinary measures of the kingdom, certain standards were preserved in the exchequer, with which all rods were required to be compared before they were stamped as legal measures. The oldest of these standards in existence dates from the reign of Henry VII.; but it has long been disused; and that which, till the year 1824, was considered as the legal standard, was a brass rod, of the breadth and thickness of about half an inch, placed there in the time of Elizabeth. There was another similar rod of the same date, called an *ell*. The ell, however, does not appear ever to have been established as a legal measure; but was conventionally considered as equal to a yard and a quarter. To these rods belonged a brass bar, on one edge of which was a hollow bed or matrix fitted to receive the square rod of a yard, and on another a like bed fitted to receive that of an ell; and into these beds were fitted the yard and ell measures brought to be examined and stamped with the standard marks. All rods so stamped became standard measures. It is abundantly obvious that measures determined in this coarse manner could have no strict claim to be

considered as *accurate* copies of the original standard; but it would seem that the standard itself was incapable of affording any definite or correct measure. Subsequently in 1742 some Fellows of the Royal Society and members of the Academy of Sciences at Paris constructed a new standard, taken from one found in the Tower; it consisted of a solid brass bar, 1·01 inch square and 39·06 inches long. At about 1½ inch from each end a gold pin or stud was inserted; in which pins, at the distance of 36 inches, are two points intended to designate the length of the yard. In 1760 Mr. Bird constructed another standard similar to that last described, of which, indeed, it was intended to be a copy. This last standard was adopted by parliament in June 1824, an Act having been passed in that year in which the unit of measure was for the first time defined, and in the following terms:—

'The straight line or distance between the centres of the two points in the gold studs in the brass rod, now in the custody of the clerk of the House of Commons, whereon the words and figures *Standard yard*, 1760, are engraved, shall be, and the same is hereby declared to be, the original and genuine standard of that measure of length or lineal extension called *a yard*; and the same straight line or distance between the centres of the said two points in the said gold studs in the said brass rod, the brass being at the temperature of 62° of Fahrenheit's thermometer, shall be and is hereby denominated the *imperial standard yard*, and shall be, and is hereby declared to be, the *unit* or only standard measure of extension.' And the Act further declared, that if at any time hereafter the said imperial standard yard shall be lost, or shall be in any manner destroyed, defaced, or otherwise injured, it shall be restored by making, under the directions of the Lords of the Treasury, a new standard yard, bearing the proportion to a pendulum vibrating seconds of mean time, in the latitude of London in a vacuum, and at the level of the sea, as 36 inches to 39·1393 inches.

This scale was destroyed by the fire which consumed the two houses of parliament in 1834. In 1838 a commission was appointed to take steps for its restoration, and the following decisions were carried out in the construction of the new one. A line standard, or a bar on which the measure of length was defined as the distance between two marks, was preferred to an end standard, in which the measure would be the whole length of the bar. The material of the bar to be gun-metal, its form a square rod 38 inches long, on which two fine lines, transverse to the axis of the bar, marked on two small gold plugs, defined the length of the standard measure. The new standards and parliamentary copies have been deposited at the Exchequer, Royal Mint, Royal Society, Royal Observatory, and the Houses of Parliament. (*Phil. Trans.* 1857.)

English System of Lineal Measures.—The unit of measure, as already stated, is the yard. The yard is divided into three feet, and the foot subdivided into twelve inches. The multiples of the yard are the pole or perch, the furlong, and the mile; five and a half yards being a pole, forty poles a furlong, and eight furlongs a mile. But the pole and furlong are now scarcely ever used, itinerary distances being reckoned in miles and yards. The relations of these different denominations are exhibited in the following table:—

In.	Feet	Yards	Poles	Furlongs	
1	0·083	0·028	0 00500	0 00012626	
12	1	0 333	0 06000	0 00151515	
36	3	1	0·1818	0·004545	0·00056818
198	16 5	5 5	1	0·025	0 003125
7920	660	220	40	1	0·125
63360	5280	1760	320	8	

Measures of Superficies.—In square measure the yard is subdivided as in general measure into *feet* and *inches*; 144 square inches being equal to a square foot, and nine square feet to a square yard. For land measure the multiples of the yard are the *pole*, the *rood*, and the *acre*; thirty and a quarter (the square of five and a half) square yards being a pole, forty poles a rood, and four roods an acre. Very large surfaces, as of whole countries, are expressed in square miles. The following are the relations of square measure:—

Sq Feet	Sq. Yards	Poles	Roods	Acres
1	0·1111	0·00367309	0·000091827	0·000022957
9	1·	0·0330579	0·000826448	0·000206612
272·25	30·25	1	0·025	0 00625
10890	1210	40	1	0·25
43560	4840	160	4	1

Measures of Volume.—Solids are measured by cubic yards, feet, and inches; 1,728 cubic inches making a cubic foot, and 27 cubic feet a cubic yard. For all sorts of liquids, corn, and other dry goods, the standard measure is declared by the Act of 1824 to be the *imperial gallon*, the capacity of which is determined immediately by weight, and remotely by the standard of length, in the following manner: According to the Act, the imperial standard gallon contains ten pounds avoirdupois weight of distilled water, weighed in air at the temperature of 62° Fahrenheit's thermometer, the barometer being at thirty inches. The pound avoirdupois contains 7,000 troy grains; and it is declared that a cubic inch of distilled water (temperature 62°, barometer thirty inches) weighs 252·458 grains. Hence the contents of the imperial standard gallon are 277·274 cubic inches. The parts of the gallon are *quarts* and *pints*; two pints being a quart, and four quarts a gallon. Its multiples are the *peck*, the *bushel*, and the *quarter*: the peck being two gallons, the bushel four pecks, and the quarter eight bushels. The following are the relations:—

Pints	Quarts	Gallons	Pecks	Bushels	Quarters
1	0·5	0·125	0·0625	0·015625	0·001953125
2	1	0·25	0·125	0·03125	0·00390625
8	4	1	0·5	0·125	0·015625
16	8	2	1	0·25	0·03125
64	32	8	4	1	0·125
512	256	64	32	8	1

For an account of the various other measures used in commerce, see the *Commercial Dictionary*; or Colonel Pasley's *Observations on the Measures, Weights, and Money used in this Country* (London 1834), where a full description is given.

French System of Measures.—The French system of measures, introduced during the Revolution, has for its standard the length of a quadrant of the earth's meridian. The unit of measures of length is the *mètre*, which is a ten-millionth part of the quadrant. This length, deduced from the great trigonometrical measurement of the meridian from Dunkirk to Barcelona, is marked by two very fine parallel lines drawn on a bar of platinum, and preserved in the archives of the Academy of Sciences. From a comparison of the standards of this country with a copy of the mètre in the possession of the Royal Society, Captain Kater found the length of the mètre to be 39·37079 inches of the English standard. (*Phil. Trans.* 1818.) Mr. Baily found the length of the mètre to be 39·3696786 inches of the Royal Astronomical Society's scale (*Mem. R.A.S.* vol. ix. p. 133), from which, by reducing to the imperial standard yard by the data given in the same memoir, the true length of the mètre is 39·370091 inches of the imperial yard. The comparison is, however, attended with some degree of uncertainty, from the circumstance that a reduction must be made for the expansion of the metals; the standard temperature of the English measures being 62° Fahrenheit, and that of the French measures 32°, or the temperature of melting ice.

In the French system the unit of superficial measure is the *are*, a surface of ten mètres each way, or one hundred square mètres. The unit of measures of capacity is the *litre*, a vessel containing the cube of a tenth part of the mètre, and equivalent to 0·220097 parts of the British imperial gallon. The standard temperature is that of melting ice. All the divisions and multiples of the units are decimal; and the principle of nomenclature adopted was to prefix the Greek numerals to the decimal multiples, and the Roman numerals to the decimal subdivisions.

No system of metrology hitherto invented can be compared with this of the French in a scientific point of view; whilst its convenience for the purposes of commerce is now so generally admitted by those who have made themselves intimately acquainted with its working, that its universal adoption by all civilised nations cannot be much longer delayed. [METRIC SYSTEM.]

Of the different measures of length used in European countries, the foot is the most universally prevalent. We subjoin the relation between the foot of different countries and the English foot:—

	English foot
Russian foot . .	= 1
Paris foot . .	= 1·065765
Prussian and Danish foot	= 1·029722
Bavarian foot . .	= 0·957561
Hanoverian foot . .	= 0·958333
Saxon foot . .	= 0·929118
Austrian foot . .	= 1·037128

Comparative tables of the measures used in different countries are given in various works; one of the most complete and convenient will be found in Hulsse's *Sammlung Mathematischer Tafeln*, Leipzig 1840. For further information on the subject of this article, see Pauchton's *Métro'ogie, ou Traité des Mesures*, Paris 1780; Kelly's *Universal Cambist*, 1821. [LEAGUE; MILE; WEIGHT.]

MEASURE. In Music, the same as BAR [which see].

Measure of Curvature. [CURVATURE.]

Measures. In Geology, this word is sometimes used as synonymous with beds or strata; as *coal measures*.

Measures and Weights, Ancient English. The basis of the ancient English measures of capacity and weight was the ancient Anglo-Saxon pound. The pound contained 5,400 grains, these grains being 22½ to the pennyweight, and the pennyweight being calculated as 32 grains of average quality dry wheat, taken from the middle of the ear. Eight of these pounds were to form the gallon of dry and liquid measure, 8 of these gallons the bushel, 8 of these bushels the quarter. The old English pound, therefore, stood to the troy pound in the relation of 15 to 16. Some few standard gallons and bushels have been preserved, and are generally found to be somewhat less than the exact proportion indicated by this calculation. The troy pound was not known as a legal standard, it would appear, till certain changes were introduced into the currency by Henry VIII.

Again, the sack of wool was roughly calculated as equal in weight to the quarter of corn; 15 Saxon ounces formed the *libra mercatoria*, i.e. the pound of 7,000 grains with which we are familiar under the name of *avoirdupois*. Fourteen such pounds made the stone of wool, and 28 such stones constituted the sack. Such a calculation will be found to make the sack of wool lighter than the quarter of wheat by nearly four pounds.

Another element of weight was the charrus of lead. This contained 2,100 avoirdupois pounds, and divided by the old hundred, i.e. 108 lbs., will be found to contain nearly 19½ hundred, that is the modern fother or fodder. The charrus contained 30 fotmale, or pedes, each pes containing six stone less 2 lbs. The foot or pig will be found to be the tenth of a cubic foot of lead.

Iron was measured by the piece, 25 of which formed the hundredweight of 108 lbs. Wax and spices were reckoned by the same hundred. Foreign cloth was sold by the piece of 24 ells long and 2 broad, the exactness of the measure being secured by a rigorous assize. Aylesham linen was, however, only ¾ broad.

Wine was sold by the tun of 252 gallons, i.e. it contained 4½ French or 10 Spanish hogs-

heads. A familiar division is that of the sextary or six gallons.

A last of wool was 12 sacks; a last of herrings ten thousand, each hundred being 120. A last of hides was 100, that is 10 dakers or dikers, each diker being 10.

The foot, the yard, and the acre were the same as at present. The fullest account of ancient English measures, though apparently with some corruptions in the text, is to be found in Fleta, *De Legibus Angliæ*, lib. ii. cap. xii. The assize of weights and measures was the duty of the coroner, and the duty of stamping them belonged to the justices in eyre. The coroner was assisted by a jury of twelve men, who might be villeins if necessary.

Measurement of Ships. [TONNAGE.]

Meat, Preservation of. [PRESERVATION OF MEAT.]

Meatus Auditorius. [EAR.]

Mecca Balsam. The produce of the *Balsamodendron gileadense*, growing at Gilead, in Judæa. It is also called *Opobalsamum*.

Mechanical Curve. A curve of such a nature that the relation between the absciss and the ordinate cannot be expressed by an algebraic equation. Such curves are now more commonly called *transcendental curves*. [CURVE.]

Mechanical Powers. The six simple machines known as the LEVER, the WHEEL AND AXLE, the INCLINED PLANE, the WEDGE, the SCREW, and the PULLEY [see the respective terms].

Mechanical Solution of a Geometrical Problem. In the constructions of pure geometry only the ruler and compasses are allowed to be used; or, in other words, the constructions are required to be effected by means of straight lines and circles only. The ancient geometers soon discovered that there were many problems (such as the duplication of the cube and the trisection of an angle) which could not be constructed by these means. They hence had recourse to other instruments (*machinæ*) to effect this purpose; and such solutions were distinguished from the geometrical ones by the term *mechanical*.

Mechanical Work. The exertion of force through space. It is estimated in foot-pounds, the unit being the work performed in raising one pound avoirdupois, against gravity, to a height of one foot. In the modern mechanical theory of heat the utmost mechanical work that can be accomplished by the expenditure of a quantity of heat sufficient to raise one pound of water one degree (Fahrenheit) in temperature, is called the *mechanical equivalent of heat*. According to Joule's experiments it is equal to 772 foot-pounds.

Mechanics (Gr. μηχανή, *machine*). In Natural Philosophy, the science which treats of forces and powers, and their action on bodies, either directly or by the intervention of machinery.

The theory of mechanics, which is a branch of mixed mathematics, is founded on an axiom or principle called the *law of inertia*, or Newton's *first law of motion*; namely, that a body must remain for ever in a state of rest, or in a state of uniform and rectilineal motion, if it be not disturbed by the action of an external cause. Theoretical mechanics is, therefore, divided into two parts: *statics*, which treats of the equilibrium of forces; and *dynamics*, which is the science of accelerating or retarding forces, and of the actions which those forces produce. When the bodies under consideration are in the fluid state, these become respectively *hydrostatics* and *hydrodynamics*, which are comprehended under *hydraulics*, and sometimes the terms *aërostatics* and *aërodynamics* are used to denote the corresponding divisions of pneumatics; but all these divisions are more frequently included under the general term *mechanics*.

Practical mechanics, or a knowledge of the effects of some of the mechanical powers, must have existed to some extent from the earliest ages of the world; but of the machines used by the ancients in their constructions, the oldest extant account is contained in the *Architecture* of Vitruvius. Archimedes, in his treatise *De Æquiponderantibus*, first investigated theoretically the principles of equilibrium; and the same philosopher is celebrated for the mechanical contrivances by which, in the siege of Syracuse, he so long frustrated the efforts of the Roman army under Marcellus. During the eighteen centuries which succeeded the age of Archimedes, the theory of mechanics remained in the same state. Galileo laid the foundations of modern dynamics by his discovery of the law of accelerating forces, and by reducing the propositions of that science to mathematical formulæ. Sir Isaac Newton, by his invention of fluxions, enabled mathematicians to complete what Galileo began.

Although we possess many works of the highest order on isolated branches of mechanics, Poisson's *Traité de Mécanique* (Paris 1833) still remains the most complete treatise on the subject. Of first-class elementary treatises in English a great number might be cited; of the more recent ones, that by Price in the 3rd and 4th volumes of his *Treatise on the Infinitesimal Calculus* (Oxford 1856) deserves high commendation.

Mechanics' Institutes. Mechanics' institutes may be safely said to owe their origin to Dr. Birkbeck, who, in 1800, delivered a course of lectures on natural philosophy and its application to the arts before an audience composed entirely of the mechanics of Glasgow, though it was not until after the lapse of twenty years that his idea was followed up. Institutions of this sort are at present established in almost every town in England whose population amounts to 10,000, and in some of much smaller number. They are supported partly by contributions, and partly by the subscriptions of the members. Short courses of lectures, illustrated with experiments, are given on popular and interesting subjects, and reading rooms are

attached to the greater number of these institutions, which, speaking generally, are well attended. (*Stat. of Brit. Empire*, vol. ii. p. 359.)

Mechanists. Those philosophers who refer all the changes in the universe to the effect of merely *mechanical* forces, such as *impact*, *weight*, and the like. They are opposed to the dynamical philosophers, or those who assume a living and spontaneous power in nature, antecedent to and different from the phenomena present to the senses. [MATERIALISM.]

Mechoacan. One of the names of *Batatas Jalapa*, the tuberous roots of which possess purgative properties, analogous to those of the true jalap.

Meconic Acid (Gr. μήκων, *the poppy*). The peculiar acid with which morphia and perhaps some of the other organic bases are combined in opium. When pure, it forms small white crystals. The salts of this acid are termed *meconates*; those of lime, baryta, lead, and silver are white, and soluble in nitric acid. This acid is tribasic, and the somewhat anomalous formula $3HO,C_{14}HO_{11}$, has been assigned to it. One of the principal characters of this acid and of its salts is that of forming a compound with the peroxide of iron of an intensely red colour, very similar to that of the sulphocyanate of iron, but differing in the fact that a solution of corrosive sublimate does not destroy the red colour; hence a persalt of iron is an excellent test of its presence, and by it opium may sometimes be recognised, when the quantity is so small as to render the morphia very difficult of detection. This red colour is destroyed by heat, by sulphurous acid, and by protochloride of tin. Meconic acid in solution gives a yellowish-white precipitate with acetate of lead, and this precipitate is not dissolved by acetic acid. It is medicinally inert.

Meconin (Gr. μήκων). *Opianyl.* A white neutral fusible substance, procured from opium. About two grains of it are said to be contained in a pound of opium.

Meconium (Gr. μηκώνιον, *the juice of* μήκων, *the poppy*). Opium. The term is also applied to the excrement found in the lower part of the fœtal intestines.

Medal (Ital. medaglia, Fr. medaille). A piece of metal, in the shape of a coin, bearing figures or devices, struck and distributed in memory of some person or event. Ancient coins, although intended for the purpose of circulation, are also commonly termed medals. [NUMISMATICS.]

Medallion (Fr. medaillon). In Architecture, this word is applied to carvings on the plain spaces of the walls, surrounded by a raised border.

MEDALLION. In Numismatics, this name is appropriated to coins struck in Rome and in the provinces under the empire, which, in gold or silver, exceed in size the largest coins of which the name and value are known in those respective metals; viz. the aureus in gold, and the denarius in silver. It has been doubted whether they were intended for the purpose of circulation, or merely struck, like modern medals, to commemorate persons or events. [NUMISMATICS.]

Medea or **Medeia** (Gr.). In Greek Mythology, a daughter of Æetes, king of Colchis, in whose palace was preserved the golden fleece of the ram which had borne Phrixus and his sister Hellê from the house of Athamas. The recovery of this golden fleece was the task imposed by Pelias, king of Iolcos, upon Jason, who sailed from Thessaly with a large number of Hellenic chieftains in the ship Argo, and after having passed through the Symplegades, arrived at length in Colchis. Here Æetes promised to give him the fleece, on condition that he should first plough the land with fire-breathing bulls, and sow it with dragon's teeth. These conditions Medea, the wise maiden, whose love Jason had obtained, enabled him to perform. She anointed his body with an ointment which protected him against the fiery breath of the bulls, and told him to cast a stone among the armed men who sprang from the dragon's teeth, so that they should fight with and slay one another. Then leading Jason to the secret place where the fleece was kept, she lulled to sleep the dragon that guarded it, and then left Colchis with Jason, who had now performed the bidding of Pelias.

But Medea had sworn to avenge the wrong done to Jason; and as she abode in the house of Pelias at Iolcos, she persuaded his daughters to cut up his body and boil his limbs in a cauldron, in the belief that he would thus be restored to youth. Medea purposely omitted to pronounce the spell at the right time, and the limbs of Pelias were consumed by the fire. She then took Jason in her dragon chariot to Argos, where he fell in love with Glaukê, the daughter of the king, Creon. Disguising her wrath, she gave to Glaukê, as bridal presents, a wreath with a robe which Helios (the sun) gave her before she left the house of her father Æetes. But the magic gifts ate into her flesh, and Creon, who tried to save her, died with his daughter Glaukê, while Medea fled from the land in her dragon chariot. In the sequel of the tale, she slays her children by Jason—a crime closely resembling the slaughter of Pelops by Tantalus.

The connection of this myth with other solar legends is obvious. In the Homeric hymn to HERMES [which see], the sun god Phœbus is represented as possessed of a hidden wisdom which Hermes vainly seeks to attain. This wisdom is inherited by Asklepios (Æsculapius), the son of Phœbus, and by Medea, the Colchian maiden. The very gift which Helios bestows on her reappears in the story of Deianeira, whose robe scorches the body of Heracles. The robe is, in fact, the same as the golden fleece, and its destructive power is exhibited in the deadly arrows of Philoctetes, the sword of Theseus and of Perseus, the spear of Artemis, Meleagros, and Achilleus. In the legend of

Medea, Jason plays the part of Paris in that of Œnônê, and Glaukê answers to the Argive Helen. The slaughter of Medea's children is one of the many forms under which is displayed the destructive power of the sun on the fruits which he has produced. This idea is prominent in the myths of Phaethon, Lykaon, and Tantalus, while the notion of the sun's secret wisdom presents one of the sources from which seem to have sprung the theories of sorcery and witchcraft.

Mediæ (Lat.). The three letters *b*, *g*, and *d* (beta, gamma, delta) are so called in the Greek alphabet, as holding respectively a middle place between their several *tenues*, *p*, *k*, *t* (pi, kappa, tau), and aspirates, *ph*, *ch*, *th* (phi, chi, theta).

Mediant. In Music, the third note of the scale, which is a major or minor third higher than the key note, according as the mode is major or minor.

Mediastinum (Lat. from medius). The space left in the median line of the chest by the non-approximation of the two lungs. It extends from the sternum in front to the spine behind, and contains all the thoracic viscera excepting the lungs.

Mediatisation. The annexation of the smaller German sovereignties to larger contiguous states, which took place, on a large scale, after the dissolution of the German empire in 1806. The same thing had been done on various occasions during the continuance of the empire; and the dominions so annexed were said to be mediatised, i.e. made mediately instead of immediately dependent on the empire. The term was retained when the abolition of the German union had rendered it in strictness inappropriate. A few more were mediatised after the peace of 1815. See *Conv. Lex.*; and Hawkins's *Germany*, 1838, which contains a chapter on this subject.

Medicago (Gr. Μηδική, a term applied by Dioscorides to a Median grass). A genus which affords some agricultural fodder plants. *M. sativa* is the Lucern so much cultivated as green food for horses and cattle; and *M. lupulina* is the Nonsuch introduced into pastures along with grasses and clovers.

Mediterranean Sea. This large and beautiful sea, separating Europe from Africa, opening into the Atlantic only by the narrow straits of Gibraltar, and communicating with the Black Sea by the straits of the Hellespont and Bosphorus, between which lies the narrow sea of Marmora, contains nearly a million square miles of water, of considerable depth, and much more salt than the great ocean. Its waters are several degrees warmer than those of the Atlantic, and the evaporation from it, from various causes, is excessive. The depth of some parts is as much as a thousand fathoms. The shores of the Mediterranean are exceedingly indented; and many islands, some of large size, and most of them of singular historical interest, are contained in it. The islands of Sardinia and Corsica, the Baleaiic Islands, Malta, Sicily, the Ionian Islands, the islands of the Greek Archipelago, and others, are all familiar examples.

The Mediterranean is crossed by a submarine bank, almost connecting Sicily with Africa, and nearly dividing the sea into two parts. The eastern portion is in some respects distinct from the western. It receives many important streams, of which the Nile is the principal; but the supply of fresh water is by no means equal to the evaporation from the surface, and thus a constant current sets inwards through the straits of Gibraltar to supply the deficiency.

Very large parts of the Mediterranean are more or less directly influenced by volcanic action and earthquakes, and more than once its bed has been broken, and perhaps upheaved, and islands have suddenly appeared where before there had been deep water. The great volcanoes of Etna and Vesuvius, the smaller but constantly erupting volcanoes of the Lipari islands, and the volcanic rocks of the eastern shores, all prove that subterranean fires largely act under its bed; and the occasional evidence of slow upheaval or depression on the coasts of Italy, prove that the action, so far as great eruptions are concerned, although intermittent, is constantly going on.

The shores of the Mediterranean include some of the most interesting districts of the civilised world. They branch into several seas, of which the Adriatic and the Ægean are the most familiar. They possess many harbours and ports, and the shores are picturesque in the highest degree.

Several currents of small magnitude have been observed in this inland sea. They are for the most part sluggish and very variable, and seem to depend on prevalent winds. There is a slight tide in most parts of the Mediterranean; but it is greatly masked by the effect of winds.

Medium. In Physics, the substance or matter in which bodies exist, or through which they move in passing from one point to another. The resistance which different mediums oppose to bodies in motion is proportional to the respective densities of the mediums. Newton supposed the existence of a universal medium, or ether, infinitely more rare or subtile than air, and diffused through the whole creation. The modern discoveries of the propagation of light by undulation, and of the acceleration of some of the small comets, caused apparently by the resistance which it offers (hence the term *resisting medium*), give great probability to this supposition.

Medjidite. A sulphate of uranium and lime, found near Adrianople, in Turkey, and named after the late sultan Abdul Medjid.

Medlar. The fruit of the *Mespilus germanica*, a plant found wild in several parts of Central Europe. It is remarkable for the austerity of its fruit when first gathered, and for its total loss of that quality after a few weeks, when it becomes soft, brown, and sweet—a condition called *bletted*, from the French *blet*, over-ripe. Of the garden varieties the Dutch medlar is the finest as to size, and the Notting-

ham the most delicate in flavour. In the eyes of a botanist the medlar is only a hawthorn berry of large size.

Medulla (Lat. *marrow*). In Botany, the pith or central column of an Exogenous plant. It has sometimes been called *medullin*.

Medulla Oblongata. In Anatomy, the name given to the mass of grey and white neurine contained in the occipital segment of the cranium, and forming the medium of connection between the spinal marrow (myelon) and the brain (encephalon): it is sometimes described as the cephalic prolongation of the myelon; but it has distinct and higher functions, and constitutes the chief part of the epencephalic division of the brain. [BRAIN.]

Medulla Spinalis (Lat. *the spinal pith*). In Anatomy, the part of the nervous axis which is contained in the vertebræ of the trunk. [MYELON.]

Medullary. Belonging, or alike in nature, to marrow, as *medulla spinalis*, the *myelon* or spinal marrow; *medulla oblongata*, that part of the myelon which lies within the basioccipital bone; medullary substance, the white substance of the brain, and the inner, as opposed to the cortical substance of the kidney.

Medullary Rays. The vertical plates of cellular tissue which radiate from the centre of the stem of Exogenous plants, through the wood to the bark. They cause that appearance in timber which carpenters call silver grain, or flower of the wood.

Medullary Sheath. A thin layer of vessels which surround the pith of Exogenous plants, and thence extend into the leaves and parts of fructification.

Medullary Substance. The interior white portion of the brain. The *medulla oblongata* is a part of the brain, lying upon the basilar process of the occipital bone, and formed by the junction of the crura of the brain and cerebellum. It terminates in the spinal marrow.

Medusa (Gr. *μέδουσα, a ruler*). In Mythology, the mortal GORGON [which see]; according to Hesiod, the daughter of Keto and the sea-god Phorkys, whose face turned all who looked upon her into stone. She was slain by Perseus, who placed her head on the ægis of Athênê, where it retained its petrifying power.

MEDUSA. In Zoology, a name given by Linnæus to a genus of marine animals, now forming an extensive tribe (*Medusaria*) in the class *Acalepha* of the Cuvierian system. The body is in the form of a gelatinous disc, more or less convex above, called the *umbel*, from the centre of which, and from the margin, there depend in most of the species processes or filaments more or less numerous, and more or less elongated. The *Medusæ* are commonly known by the name of *sea-blubber*, *jelly-fish*, &c. They have a stomach or digestive cavity excavated in the centre of the disc, and opening externally either by a central and inferior crucial mouth, or continued into branched appendages, and receiving the nutriment by innumerable minute pores, analogous to the *stomata* of plants, or those root-like appendages. The digested fluid is conveyed by vessels from the stomach to an exquisite network or plexus situated on the under surface of the border of the disc, where it receives the influence of the atmosphere, and is fitted for assimilation. Some species, as the *Medusa aurita*, have also intestinal canals leading from the stomach to separate anal outlets. Traces of a nervous system and rudimental organs of vision have been discerned in some of the *Medusæ*. They swim by muscular contraction of the margins of the disc. They are of distinct sexes, which congregate together chiefly in the autumnal months. The male and female organs much resemble each other, and are situated, in both sexes, in corresponding cavities, generally four in number, on the under surface of the disc. The ova are received when impregnated in marsupial sacs appended to the arms (in *Medusa aurita*), whence they escape in the form of ciliated infusoria, afterwards assume the structure of eight-armed polypes, pass the winter in this state, and undergo their final transformation in spring. Notwithstanding the complication of the organic machinery, functions, and generative economy of the *Medusæ*, their solids form so small a proportion of their frame that, of a Medusa of ten pounds weight, what remains upon the filter through which its fluid parts (chiefly sea-water) have escaped does not exceed two drachms. A great number of the *Medusæ* are phosphorescent, shining in the night like globes of fire; but the nature and the agents of this wonderful property remain to be discovered. Most of the *Medusæ* at certain seasons sting and inflame the hand that touches them; but the cause of this property is equally unknown.

Meerschaum (Ger. *foam of the sea*). A hydrous silicate of magnesia. It is found in various parts of Europe, but chiefly in Asia Minor, in stratified, earthy, or alluvial deposits, at the plains of Eski-shehr, and in Natolia at Kiltschik near Konieh. It is dull and opaque, white or yellowish in colour, adheres to the tongue, yields to the nail, and has a specific gravity of only 1·3 to 1·6. In the Turkish dominions it is used as a substitute for fuller's earth, and for washing linen. The principal use of Meerschaum is in the manufacture of tobacco pipes, which are prepared for sale in Germany by being soaked in melted tallow or wax, and afterwards polished. Imitation meerschaum pipes are sold in large quantities, and care is necessary to guard against deception. The best criterion is the peculiar brown colour which the genuine Meerschaum pipe assumes after having been smoked some time.

Megabromite. A variety of chloro-bromide of silver found in limestone at Copiapo in Chili.

Megalesian Games. One of the most magnificent of the Roman exhibitions of the circus; in honour of Cybele, as ἡ μεγαλη θέος, *the great goddess*, the mother of the gods.

Megalichthys (Gr. μέγας, *great*, and ἰχθύς, *a fish*). An extinct genus of fishes, including species of great size; one of which, the *Megalichthys Hibberti*, has left its teeth and other parts in the cannel coal of Fifeshire, and the Edinburgh coal-field.

Megalonyx (Gr. μέγας, and ὄνυξ, *a claw*). A large fossil mammalian, the remains of which were found in a cavern in the limestone of Virginia in America.

Megalopterans (Gr. μέγας, and πτερόν, *a feather*). A name given by Latreille to a family of Planipennate Neuropterous insects, comprehending those which have large wings horizontally folded.

Megalosaurus (Gr. μέγας, and σαῦρος, *a lizard*). The generic name applied by Dr. Buckland to an extinct genus of gigantic Saurians, discovered by him in the oolitic slate of Stonesfield, near Oxford. The species on which the genus is founded included individuals measuring from forty to fifty feet in length; they partook of the structure of the crocodile and monitor. The entire skeleton has not as yet been found. The femur and tibia measure nearly three feet each; and a metatarsal bone has been found of the length of thirteen inches. The bones of the extremities have large medullary cavities. The generic character is principally founded on the teeth, which Dr. Buckland thus describes: 'In the structure of these teeth we find a combination of mechanical contrivances analogous to those which are adopted in the construction of the knife, the sabre, and the saw. When first protruded above the gum, the apex of each tooth presented a double cutting edge of serrated enamel. In this stage its position and line of action were nearly vertical, and its form like that of the two-edged point of a sabre, cutting equally on each side. As the tooth advanced in growth, it became curved backwards, in form of a pruning knife, and the edge of serrated enamel was continued downwards to the base of the inner and cutting side of the tooth; whilst on the outer side a similar edge descended but to a short distance from the point, and the convex portion of the tooth became blunt and thick, as the back of a knife is made thick for the purpose of producing strength. In a tooth thus formed for cutting along its concave edge, each movement of the jaw combined the power of the knife and saw; whilst the apex, in making the first incision, acted like the two-edged sabre. The backward curvature of the full-grown teeth enabled them to retain, like barbs, the prey which they had penetrated.' (*Bridgewater Treatise* i. p. 238.) These formidable teeth, which sufficiently bespeak the carnivorous and predatory nature of the extinct monster, were arranged in a pretty close series, in sockets, along the alveolar border of the jaws.

Meganycterans (Gr. μέγας, and νυκτέρις, *a night bird* or *bat*). The first division or tribe of the order *Cheiroptera*, including the largest species of bats, or *flying foxes*; which, however, are exclusively vegetable feeders, living mostly on soft fruits, and having the molar teeth adapted to that kind of food by their broad simple crowns. The tribe is also distinguished from the animal-feeding bats, whether bloodsuckers or insect-catchers, by having the two innermost fingers armed with hook-shaped claws, and by the simple structure of the nose and ears. The alimentary canal, and especially the stomach of the great frugivorous bats, are likewise more complicated than in the other tribes. The meganycterans are distributed over the warmer parts of Asia, Africa, and the Polynesian Isles, but do not exist in America. They comprise the genera *Hypoderma*, *Pteropus*, and *Harpyia*.

Megarian School of Greek Philosophy. This school, founded at Megara by the disciples of Socrates, who retired thither after his death, was distinguished by its logical subtlety. Its most celebrated names were those of Euclides, Eubulides, and Stilpo.

Megastomes (Gr. μέγας, and στόμα, *mouth*). The name of a family of Univalve shells, comprehending those which are not symmetrical, and which have a very large aperture or mouth.

Megatherium (Gr. μέγας, and θηρίον, *a beast*). The name given by Cuvier to a genus of extinct Edentate quadrupeds, including and represented by one of the most gigantic of terrestrial mammalia. The haunches of the *Megatherium Cuvieri* were more than five feet wide, and its body twelve feet long and eight feet high; its feet were a yard in length, and terminated by formidable compressed claws of immense size; its tail was of great length, and probably much larger than that of any other extinct or living terrestrial mammal. The head of the megatherium was relatively small: the cranium presents many of the peculiarities of that of the sloth. The upper jaw was armed with five teeth on each side, the lower jaw with four on each side: all the eighteen teeth belong to the molar series. They were perpetually growing, like the incisors of the Rodents; but had their grinding surface traversed by two transverse ridges, and their texture composed, as in the teeth of the sloth, of a central body of coarse ivory, a thick outer coating of cæmentum, and a thin intermediate layer of fine and dense ivory, which forms the prominent terminating ridges of the crown.

Nothing certain is known of the nature of the integuments of this singular and enormous animal; but the fossil bony armour which was once conjectured to have appertained to the megatherium unquestionably belongs to another species of gigantic Edentates, more nearly allied to the armadillo. [GLYPTODON.]

Megrim (Fr. migraine, from Gr. ἡμι κρανία). A violent intermitting pain affecting one side of the head.

Meionite (Gr. μείων, *less*). A silicate of alumina and lime, found in grains or small crystals of a whitish or greyish white colour at Monte Somma near Vesuvius. The name implies that the terminating pyramids of the

crystals are lower than in Idocrase, and consequently that the axis of the primary form is shorter.

Melaconite (Gr. μέλας, *black*, and κόνις, *powder*). An earthy black oxide of copper found in Cornwall and elsewhere.

Melæna (Gr. μέλαινα, fem. of μέλας, *black*). A disease characterised by the passage of dark coloured blood by stool. The pitch-black appearance of the evacuations is so striking, that, when they are once seen, the nature of the affection denoted can scarcely be mistaken. The cause exists apparently in a congested state of the liver and stomach, and the treatment consists in the free use of mercurial purges. The ancients considered that the dark-coloured stools were composed of black bile; but the correct inference from all that we know of the pathology of the disease, is, that the blood passed by stool comes from the congested stomach, having acquired its black colour from contact with the gastric juice. Hippocrates speaks of a μέλαινα νόσος characterised by the vomiting of black blood, but this more properly comes under the title of *hæmatemesis* in modern nosology.

Melaleuca (Gr. μέλας, *black*, and λευκός, *white*). A genus of *Myrtaceæ* consisting of trees and shrubs, abounding in volatile aromatic oil. *M. minor* yields by distillation of its leaves, after fermentation, the green aromatic oil called Cajaputi or Cajeput oil, a valuable antispasmodic and stimulant. The species are natives of Australia and the islands of the Indian Ocean.

A substance formed during the distillation of a mixture of sal-ammoniac and sulphocyanide of potassium.

Melamine. A colourless crystalline salifiable base derived from melam, by boiling with strong solution of potash.

Melampodium (Gr. μελαμπόδιον). The name of a modern genus of weedy *Compositæ*. *Melampodium* was one of the Greek names given to the Black Hellebore [HELLEBORUS], with which the modern plant has no relation.

Melampyrine. A crystallisable substance, soluble in water and nearly insipid, contained in the *Melampyrum nemorosum*.

Melanasphalt. A name given to the Albert Coal of Nova Scotia in consequence of its resemblance to Asphalt.

Melancholy (Gr. μελαγχολία, *black bile*). A disease of the mind, chiefly characterised by ungrounded apprehension of evil. Melancholy is correctly designated a form of insanity when it continues for an inordinate period after any given cause of grief has been removed. It is undoubtedly so when it arises without the operation of any mental cause. We find it connected with dyspepsia, with constipation, and other signs of physical disease. Systematic writers speak of various forms of melancholic insanity, such as the religious, the nostalgic, &c.

Melania. A genus of fluviatile Pectinibranchiate Gastropods, having a moderately thick shell, with an aperture longer than it is wide, enlarging opposite the spire, and the columella without folds or umbilicus: the length of the spire is various. They have long tentacula, with the eyes on their external side, and at about the third of their length from the base.

Melanic Acid. An amorphous black substance derived from hydride of salicyl.

Melanin. The black pigment of the eye. When separated from the surrounding membrane, it is a heavy black powder insoluble in water, alcohol, and ether.

Melanite (Gr. μέλας). A variety of Iron-lime Garnet, occurring in black dodecahedrons in the older lavas of Vesuvius. Those found at Frascati near Rome are locally called *Black Garnets of Frascati*. [GARNET.]

Melanochroite (Gr. μέλας, *black*; χρόα, *colour*). Chromate of lead, found massive and in tabular rhombic prisms, of a colour between cochineal and hyacinth red, at Beresow, in Siberia. The name has reference to the change of colour which the mineral undergoes before the blow-pipe.

Melanogal[illegible] A synonym of *Metagallic acid*.

Melanorrhœa (Gr. μέλας, *black*, and ῥέω, *I flow*). A genus of *Anacardiaceæ* consisting of large trees natives of India. *M. usitatissima*, common in Indian forests, produces a dark-coloured wood of excessive hardness, so heavy that anchors for native boats are made of it; and also a valuable black varnish, obtained by tapping the trees.

Melanosis (Gr.). A malignant disease, characterised by deposition of a black matter in various parts of the body.

Melanotannic Acid. The black substance formed by the action of excess of potassa upon tannic or gallic acid.

Melanterite. A mineralogical synonym for Native Sulphate of Iron [COPPERAS], derived from the word *Melanteria*, made use of by Pliny to denote the same substance.

Melanthaceæ (Melanthium, one of the genera). An order of Endogenous plants belonging to the Lilial alliance, with a regular six-parted inferior perianth, and six stamens with the anthers looking outwards. The number of species included in it is inconsiderable; but among them are the *Veratrum*, or White Hellebore, and *Colchicum*, or Meadow Saffron, the poisonous qualities of which indicate the general properties of the order.

Melanurenic Acid. A product of the action of heat on urea.

Melas (Gr. *black*). A disease endemic in Arabia: it consists in the formation of dark brown or black spots upon the skin.

Melasma (Gr.). A disease of aged persons, in which a black spot appears upon the skin, which forms a foul ulcer. A form of melasma is now described by nosologists in connection with disease of the supra-renal capsules, constituting the pathological condition known as *Addison's disease*.

Melasomes (Gr. μέλας, and σῶμα, *body*). A tribe of Heteromerous Coleopterous insects,

comprising those which are of a uniform black or grey colour.

Melasses. [MOLASSES.]

Melassic Acid. An acid produced together with glucic acid by the action of potash on grape-sugar.

Melastomaceae (Melastoma, one of the genera). A natural order of Exogenous plants belonging to the Myrtal alliance, with polypetalous flowers and strongly ribbed leaves, inhabiting tropical countries in great numbers, but unknown in Europe in a wild state, and only occurring very sparingly in the temperate parts of America. In the equatorial regions of this continent they are extremely numerous; and some of the species bear berries, the juice of which stains the mouth black; whence their name. Their most characteristic mark is to have the anthers bent downwards and prolonged into a horn, which is held fast in sockets of the ovary before the flower expands. Many of the species are ornamental.

Melchisedecians. In Ecclesiastical History, several sects of early heretics have been so termed, from the opinions entertained by them respecting the character and office of Melchisedec, arising from the language of St. Paul in the Epistle to the Hebrews. The Theodotians, in the third century, are said to have regarded him as superior to Christ. A sect of visionaries in Phrygia, who appear to have been a branch of the Manicheans, are reported to have made Melchisedec an object of adoration. Many divines of later times have entertained the belief that the Son of God appeared to Abraham under the form of Melchisedec. (Cuneus, *De Rep. Hebræorum.*)

Melchites (Syr. malek, *king*). In Ecclesiastical History, the Eutychians, when condemned by the council of Chalcedon, gave this name (royalists, imperialists) to the orthodox, who endeavoured to put the order of the emperor Marcian into execution against them. Among Oriental Christians it now designates in a general manner all those who are neither Jacobites nor Nestorians, including the Maronites, Catholic Greeks, and non-Catholic Greeks, of the three Eastern patriarchates.

Meleager or **Meleagros** (Gr.). In the Homeric Mythology, a chieftain of the Ætolian Calydon, son of Œneus and Althæa, and husband of Cleopatra. A part of the myth connected with the name of Meleagros is repeated by Phœnix to Achilleus in the tenth book of the *Iliad*, but this part relates only the war between the Ætolians and the Curêtes, in which Meleagros, angry on account of a curse laid on him by his mother for the slaughter of her brothers, refuses to aid his countrymen, until prevailed upon to do so by his wife Cleopatra. The character of Meleagros as here depicted exhibits the same readiness to take offence, the same sullen moodiness, and alternate energy and inaction which characterise both Achilles and Paris. A passing reference to his death is the only notice taken in the *Iliad* of his later history; but in the other versions the tale ran, that while he was a child, the Moeræ appeared to his mother, and said that he should live only while a brand which lay burning on the hearth should be unconsumed; that Althæa immediately extinguished the flame and put the wood carefully away, but when afterwards irritated by the death of her brothers, she threw the wood into the fire, that Meleagros died as its last spark flickered out, and that his death was followed immediately by that of his mother and his wife. Like Achilles and Paris, like Baldr and Sigurdr in northern mythology, Meleagros dies young; like them he is invincible in the field; like Theseus, Perseus, and Bellerophon, he is the destroyer of noxious beasts; in the hunt of the wild boar of Calydon, Atalantê exhibits the swiftness and strength of Daphnê, Arethusa, and Kyrênê, while the chase itself is paralleled by the exploits of Heracles and other heroes against the beasts of the field. With him die his mother and his wife, as the death of Heracles and Paris is followed by that of Deianeira and Œnônê; and as Achilles falls at the close of day, so Meleagros dies when the torch of day is burnt out. Like those heroes, again, he can only be slain in one way, or in one vulnerable spot, and his sisters weep for his death, until they are changed into guinea-hens (μελεαγρίδες), as the sisters of Phaethon shed amber tears over his dead body and are changed into poplars.

Meleagris (Gr.). A term employed by Linnæus to designate the genus of which the turkey is the type. The head and upper part of the neck is invested with a plumeless and carunculated skin: there is a cutaneous appendage of a similar construction under the throat, and another of a conical form on the forehead, which in the male, when under excitement, can be distended and elongated so as to hang over the point of the beak. From the lower part of the neck of the adult male hangs a tuft or tassel of stiff hairs. The coverts of the tail are shorter and stiffer than in the peacock, but can be erected and displayed in the same way. The tarsi of the male are armed with weak spurs. The common turkey (*Meleagris Gallopavo*, Linn.) was introduced into Europe in the sixteenth century. Its size, and the excellence of its flesh, led to its being cultivated with peculiar care: it is now common, and widely dispersed. Its wild original of the American woods is of a greenish colour, with a copper gloss. A second and much more beautiful species (*Meleagris ocellata*, Cuvier) has been discovered in Honduras: its domestication is greatly to be desired. The Guinea-fowl is the *Meleagris Numida*. [NUMIDA.]

Meles (Lat.). A genus separated by Storr from the Linnæan *Ursus*, and characterised by Mr. Bell as follows: Second incisor in the lower jaw placed behind the others; premolars $\frac{4-4}{4-4}$, molars $\frac{1-1}{1-1}$, arranged in an uninterrupted series; feet plantigrade; a glandular pouch underneath the tail, having a transverse orifice.

Since the extirpation of the common bear, the badger, *Ursus Meles* of Linnæus, which is a typical species of the present genus, is the sole representative of the Ursine family in our indigenous zoology. The habits of this quadruped are nocturnal, inoffensive, and slothful; its food consists of roots, earth nuts, fruits, the eggs of birds, insects, reptiles, and the smaller quadrupeds; its noxious qualities are consequently few and of slight moment, and by no means justify the exterminating war unintermittingly waged against it. The muscular strength of the badger is great, its bite proverbially powerful; and a dog must be trained and encouraged to enter willingly into a combat with this species. The long claws of the fore feet enable the badger to dig with effect; and he habitually dwells in burrows, which he digs by choice in declivities covered by thick coppice, or concealed in the recesses of woods. The female prepares a nest of moss and grass, and brings forth her litter of three or four blind young in the summer season.

Meletians. In Ecclesiastical History, the partisans of Meletius, bishop of Lycopolis in Egypt, deposed in a synod at Alexandria about 306, on the charge of having sacrificed to idols during the persecution by Diocletian. He was supported by numerous adherents; and thus a schism began, which was partially concluded by the submission of Arsenius, chief of the party, to Athanasius in 333, but does not seem to have been wholly extinct for 150 years.

Meliaceæ (Melia, one of the genera). A natural order of hypogynous Exogens of the Rutal alliance, known by their dotted leaves, deeply monadelphous stamens, consolidated berried or capsular fruit, and few wingless seeds. The order is moderately extensive, and includes the *Melias, Trichilias, Guarcas, Carapas*, and other interesting and useful genera of the tropical parts of Asia and America.

Meliceris (Gr. μέλι, *honey*, and κηρός, *wax*). An encysted tumour, the contents of which resemble honey.

Melilite (Gr. μέλι, *honey*, and λίθος, *stone*). A silicate of alumina, peroxide of iron, lime, magnesia, soda, and potash, found in small square prisms of a yellowish colour, and generally coated with oxide of iron, in the fissures and cavities of lava, at Capo di Bove, near Rome.

Melilotus (Gr. μέλι, *honey*, and λωτός, *lotus*). A genus of *Leguminosæ*, of which two or three species are cultivated in several parts of Europe as fodder plants, in the same way as lucern. The common Melilot, *M. officinalis*, is an annual or biennial, three or four feet high, with erect racemes of yellow honey-scented flowers. If cut continually and not allowed to flower, it will last several years. *M. alba* is the Bokhara Clover, the aromatic flavour of which recommends it for admixture with hay which has lost some of its savour. This is an excellent bee plant. The Melilots have a peculiar odour owing to the presence of *coumarin*; this is most apparent in the *M. cæruleus*, employed in Switzerland for flavouring chapziger cheese.

Meliphagans (Gr. μέλι, *honey*, and φαγεῖν, *to eat*). A family of Tenuirostres, comprising the birds which feed on the nectar of flowers.

Melitæa or **Melincea.** In Zoology, a genus of beautiful corals, and also a genus of butterflies.

Mellite. A native hydrous *mellate of alumina*. It occurs in yellowish octahedrons, and was first observed in the Brown Coal of Arten, in Thuringia.

Mellitic Acid. The peculiar organic acid contained in the mellite or honey stone of Thuringia.

Melloca. The *Melloca tuberosa*, sometimes called *Ullucus tuberosus*, is an herbaceous perennial, much cultivated throughout the elevated regions of Bolivia, Peru, and New Granada, on account of its esculent tubers, which resemble small yellow potatoes. The plant forms a genus of *Basellaceæ*, and has weak fleshy ternary stems, with fleshy heart-shaped roundish leaves and short spikes of inconspicuous yellow flowers. The tubers are called *Oca quina* in Bolivia, to distinguish them from other Ocas belonging to the *Oxalis* family.

Mellon. A lemon-yellow substance composed of six equivalents of carbon and four of nitrogen, obtained by heating dry sulphocyanogen. It is a compound radical, and combines with metals to form *Mellonides*.

Melocactus (Melon-cactus). A genus of round-stemmed or globular-ribbed succulent plants, covered with spines on the ridge of the ribs, and producing the flowers among wool, on a hairy head or cap, which is protruded from the top of the stem. They were included by Linnæus in his genus *Cactus*; and they are, in fact, scarcely distinguishable from those dismemberments of the genus to which the modern names of *Cereus* and *Echinocactus* are applied. For the sake of their grotesque form, they are often cultivated by persons curious in collecting singular vegetables.

Melodrama (Gr. μέλος, *song*, and δρᾶμα, *drama*). A short drama in which music is introduced; but differing from the opera, as the greater part of the words are recited, and not sung. In Germany, the melodrama is a short dramatic piece in lyrical verse; but among ourselves, and in France, its character is chiefly that of being a vehicle for gorgeous decoration and scenery, with an insignificant plot.

Melody (Gr. μελῳδία). In Music, the arrangement, in succession, of different sounds for a single voice or instrument, as distinguished from harmony, which is the result of the union of two or more concording musical sounds.

Meloë (Gr. μήλη, *a probe*). A genus of Coleopterous insects, of the section *Heteromera*, tribe Trachelides, and family Cantharidæ, in the system of Latreille. In this genus the antennæ are composed of short and rounded joints, the intermediate of which are the largest, and sometimes so disposed that these organs present in this point, in several males, an emargination or crescent. The wings are wanting; and the elytra, oval or triangular, with a portion

of the inner margin, crossing each other, only partially cover the abdomen, particularly in the females, in which this segment of the body is extremely voluminous. The meloës crawl along the ground, or upon low plants, on the leaves of which they feed. A yellowish or reddish oleaginous liquid exudes from the articulations of their legs. In some districts of Spain these insects are used in the place of the true blister-flies (*Cantharides*); they are also employed by the farriers. Latreille is of opinion that the modern meloës were the *Buprestes* of the ancients, insects to which they attributed very noxious properties, supposing them to be fatal to the oxen that swallowed them.

Melolonthidans. The family of Coleopterous insects of which the May-chaffer or May beetle (*Melolontha vulgaris*) is the type.

Melon. The *Cucumus Melo* of botanists, a trailing annual, much cultivated for its grateful fruit in all Eastern countries, especially in Persia, Tartary, and North-West India. In this country they can be grown with success only by the aid of artificial heat, and the fruit forms one of the delicacies of our desserts. These are what are called Musk Melons, with a rich musky flavour in the red or green fleshed fruit. Water Melons, the produce of *C. Citrullus*, are a distinct race, less rich and sugary, but with more abundant juice, and hence highly prized in hot dry countries.

Melopsite. A yellowish or greenish white Lithomarge, from Neudeck, in Bohemia.

Melpomene (Gr. μελπομένη, *the singer*). One of the nine Muses (Hesiod. *Theog.* 77); by later writers she is called the Muse of Tragedy.

Melusine. In the mediæval Mythology of France, a beautiful nymph or fairy, whose history occupies a large space in the popular superstitions of that country. She is represented as the daughter of Helmas, king of Albania, and the fairy Persine; and as having married Raymund, count of Toulouse, who built for her the magnificent castle of Lusignan (originally called Lusineem, the *anagram* of Melusine). Like most of the fairies of that period, she was doomed to a periodical metamorphosis, during which the lower part of her body assumed the form of a fish or a serpent. On these occasions she exerted all her ingenuity to escape observation; but having been once accidentally seen by her husband in this condition, she swooned away, and soon afterwards disappeared, none knew whither. But her form is said to be seen from time to time on the tower of Lusignan clad in mourning, and uttering deep lamentations; and her appearance was universally believed to indicate an impending calamity to the royal family of France.

Melyris (Gr. μέλουρις, an insect mentioned by Nicander). A Fabrician genus of Coleopterous insects belonging to the section *Pentamera*, subsection *Serricornes* tribe *Malacodermi*, and constituting the family *Melyridæ* in the system of Latreille: in which it is characterised as follows: Palpi commonly short and filiform; mandibles emarginated at the point; body usually narrow and elongated; head covered at the base by a flat or slightly convex thorax; joint of the tarsi entire, and the terminal hooks unidentate or bordered with a membrane; antennæ usually serrate, and in the males of some species even pectinate.

Membrana Tympani (Lat.). The membrane which separates the internal from the external ear. The drum of the ear. [Ear.]

Membrane (Lat. membrana). The expansion of any of the tissues of the body into a thin layer. Anatomists generally enumerate three kinds of membrane; namely, the *mucous*, the *serous*, and the *fibrous*. The mucous membranes are those which line the canals of the body which are exposed to the action of air or foreign matters, such as the lining of the nose, trachea, œsophagus, stomach, intestines, &c. The serous membranes form the lining of the sacs or closed cavities, as of the chest, abdomen, &c. The fibrous membranes are tough, inelastic, and of a tendinous character; such as the dura mater, the pericardium, the capsules of joints, &c.

Memnon. In Greek Mythology, a son of Eos (the morning) and Tithonos (=Titan, a name for the sun), represented in the legend as a son of Laomedon and brother of Priam. As Tithonos was a prince of Troy, his son, the Ethiopian Memnon, had to take part in the Trojan war, in which he was slain by Achilles; but his mythical character is again shown by the tears of morning dew, which his mother sheds on his death, just as the big drops fall from the sky when Zeus weeps for the untimely fate of his son Sarpedon. At the intercession of Eos, Zeus raised Memnon from Hades to Olympus.

The name *Memnon* is by some supposed to be a general appellation or epithet, Mei-amun, *beloved of Ammon*. The famous statue called by the Greeks Memnon, at Thebes in Upper Egypt, which possessed the real or imaginary property of emitting a sound like that of a harp at the rising of the sun, is supposed to have been in the building called by M. Champollion the Rhamesseion, from its reputed founder Rhameses, or Sesostris, of which the stupendous ruins are still seen between Medinet-Habou and Kournah. (Champollion, *Lettres écrites d'Égypte et de Nubie*, p. 261.) The statue of black granite in the British Museum, already styled the brother of the younger Memnon, was found in the Rhamesseion. The real Memnonium was, however, probably the temple said to have been erected by Amenoph or Amenothph. (Champollion, *ib.* p. 303.)

Memoir (Fr. mémoire, from Lat. memoro, *I call to mind*). In Literature, two different species of composition are popularly designated by the terms *memoir* and *memoirs*. A short biographical notice of an individual, or a short essay on a particular subject (especially to accompany and explain a map, view, facsimile, or other representation of any object in art, &c.) is called a *memoir*. This name is parti-

cularly appropriated to papers read before scientific or literary societies. The account, by an individual, of his own life, accompanied with narratives and remarks respecting the personages and events of the times in which he lived, is termed his *memoirs*; being supposed, as the name denotes, to have been drawn up with the object of assisting his memory in reflecting on past events. In modern but incorrect diction, the life of a person by another is also termed his *memoirs*, if drawn up with a somewhat less regular arrangement, and containing more matter not immediately connected with the subject than the species of narration which we term a *life*. The French were the earliest, and have always been by far the most successful writers, in this branch of literature. Their historical memoirs, partly autobiographical, and partly the works of authors who had access to the papers and memorials of those whose lives they illustrated, form a complete series from the sixteenth century to the present time, and throw the greatest light on some portions of history; while their memoirs of persons celebrated in the ranks of literature and fashion are still more numerous and interesting. In the last century this branch of literature became so popular, that any distinguished writer who did not leave authentic memoirs of himself was sure to become the subject, after his death, of fabricated memoirs, published under his name; and this species of falsification, of which Voltaire then complained, appears to be now carried on as extensively as at any former period. The collections of historical memoirs edited in Paris by Petitot, &c., contain three series of historical memoirs relating to French history, and one of English memoirs, translated, illustrating the period of our great civil war and revolution. The latter undertaking was conducted by M. Guizot.

Memorial. In Diplomacy, a species of informal state paper much used in negotiation. Memorials are said to be of three classes. 1. Memorials in the form of letters, subscribed by the writer, and speaking in the second person as addressed to another. 2. Memorials proper, or written representations, subscribed by the writer, and with an address, but not speaking in the second person. 3. Notes, in which there is neither subscription nor address. Species of the first class of memorials are: circulars from the bureau of foreign affairs sent to foreign agents; answers to the memorials of ambassadors; and notes to foreign cabinets and ambassadors.

In English Law, the transcript of a document requiring registration, deposited in the registry, is so termed; e.g. memorial of an annuity.

Memory (Lat. memoria). The power or capacity of having what was once present to the senses or the understanding suggested again to the mind, accompanied by a distinct consciousness of past existence. The term is also employed, though more rarely, to denote the act or operation of remembering, or the peculiar state of the mind when it exercises this faculty, in contradistinction to the faculty itself. Various opinions have been propounded by metaphysicians respecting the nature and origin of the faculty of memory. Upon this point, however, it is not our intention to enter into any details, as this question is so mixed up with that of other faculties of the mind, and with metaphysical questions, as to be inseparable from them. [Association; Identity, Personal; Perception.] We may, however, remark, that the ancient Platonists and Peripatetics ascribed the faculty of memory to the common theory of ideas; that is, of images in the brain, or in the mind, of all the objects of thought; and in this opinion they were supported, with slight modifications, by many other ancient philosophers. Modern thinkers for the most part regard memory as depending on the law of association. There is no doubt that, more than any other of our mental faculties, it is affected by the physical condition of the body. [Mnemonics.]

Memory, Legal. [Immemorial.]

Menaccanite. A variety of Titaniferous Iron occurring in grains and small angular fragments of an iron-black colour in Cornwall, in the bed of a stream near Menaccan.

Mendicant Friars. [Orders, Mendicant.]

Mendicity (Lat. mendicitas, *the state of a mendicus or beggar*). The condition of habitual beggars. One of the greatest curses which can afflict a civilised society is the prevalence of mendicity; and it is very much to be regretted that the prejudices of excellent and humane persons have so constantly interposed, and still interpose, difficulties in the way of the adoption and enforcement of correct principles on this subject. For there are too many who persist in seeing in mendicity only the natural expression of that indigence into which numbers are unhappily thrown by the inequality of property and uncertainty of employment prevailing in almost all communities; and who forget that the encouragement of it affords a premium to the idle, the artful, the criminal—to all or any, in short, except those really deserving sufferers whom it is the object of true charity to relieve. For the law of England, past and present, respecting mendicity, see Vagrancy. Under the operation of this law, of the national provision of the poor laws, and far more than either the activity of English industry, mendicity has been commonly regarded as less extensive and public in England than perhaps in any other country. And, owing to that very circumstance, it is perhaps worse in England than in any other country; that is, the established mendicants are more connected with the criminal part of the population. Ireland was long unhappily celebrated for the prevalence of mendicity. The number of *destitute persons* in the island was estimated by Mr. Stanley in 1837 at about 80,000 (Nicholl's *Report on Poor Laws in Ireland*); the number of street mendicants in Dublin at nearly 1,000,

or almost *one-twentieth* of the population. Sir G. C. Lewis, following the evidence adduced before the Irish Poor Law Commission, divided the habitual mendicants into: 1. Wandering beggars, chiefly cripples, blind, maimed, &c. 2. Professional strolling beggars, who have no fixed domicile, and live constantly by mendicancy. 3. Town beggars, who live by mendicancy, but have a fixed domicile: these, he says, 'are generally known by those who relieve them, and their character is not on the whole very bad.' 4. Poor housekeepers, who are relieved by three or four neighbours, to whom their wants are known, but who would not resort to general begging. (*On Local Disturbances in Ireland*, 1835.) But the administration of the Poor Law, and still more, perhaps, the extraordinary change which has taken place since 1847 in the numbers and circumstances of the Irish population, have gone a long way towards obliterating this ancient evil. In France, *dépôts de mendicité* were first founded in 1787; a kind of half way between prisons and hospitals for mendicants. Their situation was rendered dependent on their good behaviour. These receptacles held 6,000 or 8,000 persons in 1789. In 1808, by a new law, *vagabonds*, mere vagrants, were distinguished from *beggars*, i. e disabled persons, or other persons begging within their own arrondissement; and the *dépôts de mendicité* were established for each department; while under the Code Pénal, art. 174, mendicity was rendered penal. The *dépôts*, however, gradually fell into disuse. 'The road to mendicity,' says M. Sismondi, 'is now too wide and too easy; instead of calling on religion to smooth it, we should multiply as far as possible the resources of the poor, in order to prevent their being dragged into it.'

Mendipite. A native oxychloride of lead found in the Mendip Hills, Somersetshire, in white crystalline masses sometimes with a yellowish or reddish tinge.

Meneghinite. A mineral discovered by Professor Bechi in the silver-lead mines of Bottino in Tuscany, and named by him after Professor Meneghini. It is a double sulphide of lead and antimony.

Menilite. A brown and opaque variety of Opal, found in irregular nodules, which have sometimes a slaty structure, in tertiary strata near Paris; principally at Saint Ouen and Menil-Montant in beds of adhesive slate.

Meninges (Gr. μῆνιγξ, *a membrane*). The membranes which cover the brain are so called.

Meningitis. Inflammation of the membranes of the brain.

Meniscus. A lens convex on one side and concave on the other. [Lens.]

Menispermaceæ (Menispermum, one of the genera). A natural order of diclinous Exogens, typifying the Menispermal alliance, and known technically by the condition of their seeds, which are amphitropal and have a large embryo in a moderate quantity of solid albumen. They occur in the tropical woods of Asia and America, and consist of trailing shrubs, with alternate simple or lobed leaves, and small diœcious usually racemose flowers. They are bitter and narcotic, some being poisonous. *Anamirta Cocculus* yields the *Cocculus indicus* seeds which are illegally used to give narcotic properties and a bitter flavour to malt liquor; *Jateorhiza palmata* is the bitter Calumba root; and *Cissampelos Pareira* is the tonic *Pareira brava*. The order is a somewhat extensive one. [Cocculus Indicus.]

Menispermic Acid. An acid contained in the berries of the *Anamirta Cocculus* (*Cocculus indicus*), where it exists in combination with *picrotoxin*.

Mennonites. The title by which the Anabaptists of Holland came to be distinguished, after they had put themselves under the guidance of Menno, a native of Friesland, who undertook to moderate the extraordinary fanaticism of those sectarians. (Mosheim, transl. ed. 1790, v. 490.) [Baptists; Anabaptists.]

Menobranchus (Gr. μένω, *I remain*; βράγχια, *gills*). A Perennibranchiate amphibian, which retains the external gills.

Menopome (Gr. μένω, and πῶμα, *a lid*). A Perennibranchiate amphibian, which retains the opercular aperture, but not the external gills.

Menorrhagia (Gr. μήν, *a month*, and ῥήγνυμι, *I break*). Flooding; immoderate menstrual discharge; hæmorrhage from the uterus.

Mensis Philosophicus (Lat.). A chemical or philosophical month, of which the duration is variously stated; it was generally considered as including three days and nights.

Menstruum (Lat. menstruus, *monthly*). In the language of the old chemists, some preparation or drug which could only operate effectually at a particular period of the moon or month; but the term is now used for any fluid substance which dissolves a solid body.

Mensuration (Lat. mensura, *a measuring*). Though this term literally signifies the act of measuring, it is usually employed to denote the branch of practical geometry which teaches the methods of calculating the dimensions and areas of figures, the volumes of solids, &c., from the measurement of certain lines or angles of the figures or solids, which supply the requisite data.

Every rectilineal plane figure may be decomposed into triangles; and hence the mensuration of such figures resolves itself into the determination of the sides or area of a triangle. [Trigonometry.] Solids bounded by planes may in like manner be resolved into pyramids, and their contents consequently determined by the methods of elementary geometry. [Pyramid.] The determination of the lengths of curved lines, the areas of plane surfaces bounded by lines which are not all right, of the areas of curved surfaces, and of the volumes of solids bounded by surfaces which are not all plane, requires the aid of the integral calculus. [Rectification; Quadrature; Cubature.]

Mentha (Lat.; Gr. μίνθη). The genus of the Mints, several of which, as *M. Piperita*, *citrata*, *Pulegium*, *viridis*, &c., are used for culinary, medicinal, or perfumery purposes. [Mint.]

Menthene. A liquid hydrocarbon obtained by distilling the crystallisable portion of peppermint oil, or *peppermint camphor*, with anhydrous phosphoric acid. Its formula is $C_{20}H_{18}$.

Mentum (Lat. *the chin*). In Mammalogy, this term is restricted to the anterior and inferior margin of the mandible, or lower jaw. The *mentum prominulum* is that which extends beyond the perpendicular line dropped from the upper margin of the lower jaw, the human species being an example; the *mentum absconditum*, prevalent in the majority of *Mammalia*, is that which cannot be distinguished.

Menu, Institutes of. The name given to the most celebrated code of Indian civil and religious law; so called according to the myth from Menu, Menou, or Manu, the son of Brahma, by whom it is supposed to have been revealed. The word, like the Teutonic *man*, comes from a root signifying first to *measure* and then to *think*; it reappears in the Cretan Minos, who is likewise a lawgiver.

The Hindus ascribe the laws of Menu to the remotest age; and many of the most learned Europeans are of opinion that of all known works there is none which carries with it more convincing proofs of high antiquity and perfect integrity. The Institutes of Menu embrace all that relates to human life; the history of the creation of the world and man; the nature of God and spirits; and a complete system of morals, government, and religion. The work, says Sir W. Jones, contains abundance of curious matter, with many beauties which need not to be pointed out, and with many blemishes which cannot be justified or palliated: it is a system of despotism and priestcraft; both, indeed, limited by law, but artfully conspiring to give mutual support. But the most striking features by which the code of Menu is distinguished are the rigour and purity of its morals. Many of its maxims have all the sublimity of the precepts of Christianity; to which, in fact, they bear a close resemblance, not only in the style of thought, but of expression. Thus, 'Let not a man complain, even though in pain: let him not injure another in deed or in thought; let him not even utter a word by which his fellow-creatures may suffer uneasiness.' Again, 'Let him bear a reproachful speech with patience; let him speak reproachfully to no man; with an angry man let him not in return be angry; abused, let him answer mildly.' The words of the Psalmist, 'The fool hath said in his heart there is no God,' are thus almost verbally rendered, 'The wicked have said in their hearts no one sees us: yes, the gods distinctly see them, and so does the spirit within their breasts.' The Institutes of Menu have been translated into the English and French languages: into the former by Sir W. Jones in 1794, into the latter by Des Longchamps in 1830 (Strasburg). An edition of the original Sanscrit, together with Sir W. Jones's translation, was published at Calcutta in 1822–25 by Sir Graves Haughton.

Menura (Gr. μένος, *strength*; οὐρά, *a tail*). A name invented by Dr. Shaw for a genus of birds peculiar to Australia, the true affinities of which have been the subject of much discussion among ornithologists. Cuvier observes that the *Menuræ*, or lyre-pheasants, evidently belong to the order *Passerinæ*, and approach the thrushes in their beak, which is triangular at the base, elongated, slightly compressed, and emarginate at the point. Two species at least are at present known, both of which are remarkable for an extraordinary sexual developement of the tail feathers of the male. Of these there are three kinds: the twelve common ones, with very fine and widely separated barbs; two more in the middle, of which only one side is furnished with thickly-set barbs; and two external ones, curved in the figure of an *S*, or like the arms of a lyre, whose internal barbs, large and thickly set, form a kind of broad riband, while the external ones are very short, becoming longer only near the tip. The female has only the twelve ordinary quills.

Menyanthes (Gr. μένος, and ἄνθος, *flower*). A genus of Gentianaceous plants with powerful tonic properties. The *M. trifoliata*, or Buckbean or Bogbean, a wild aquatic plant, with white flowers densely crested with hairs, was employed in medicine as a bitter, emetic, tonic, and diaphoretic.

Mephitis (Lat.). Any noxious exhalation; but more particularly applied to carbonic acid gas. Mephitis was the name of a Latin goddess or sibyl who was invoked by the Romans as their protectress against noxious vapours.

Mercaptan. A liquid composed of sulphur, carbon, and hydrogen, which has received the above name from its energetic action on mercury—*corpus mercurium captans*. (Zeise, *Annales de Chimie et Physique*, lv. 87.)

Mercator's Projection. A representation of the sphere on a plane which, on account of the facilities it affords for navigation, is universally adopted for nautical charts. Meridians and parallels of latitude are represented by systems of right lines at right angles to each other; equidistant meridians by equidistant lines, but equidistant parallels by lines whose distance apart increases with the latitude in such a manner that the rhumb or sailing course towards a fixed point of the compass (in other words, every loxodromic spiral) is represented on the map by a straight line. The method was invented by Gerard Mercator (his true name was *Kauffman*, of which Mercator is the Latin equivalent), a native of Rupelmonde in East Flanders, born in the year 1512. But, though Mercator gave his name to the projection, it does not appear that he knew the law according to which the distance of the parallels from the equator increases. The true principles of the construction were found by Edward Wright, of Caius College, Cambridge, who explained them in his treatise, entitled *The Correction of certain Errors in Navigation*, published in 1599, and

are as follows: Suppose one of the meridians on the globe to be divided into minutes of a degree; one of these, taken at any parallel of latitude, will be to a minute of longitude, taken on that parallel, as the radius of the equator to the radius of the parallel; that is, as unity to the cosine of the latitude, or as the secant of the latitude to unity. This proportion holds true on the map in this sense, that if a minute of the equator be taken as the unit of a scale, then a minute of latitude will be represented by the trigonometrical secant of that latitude. Hence, in the map, while the degrees of longitude are all equal, the degrees of latitude marked on the meridian form a scale of which the distances go on increasing from the equator towards the poles, each being (approximately) the sum of the secants of all the minutes of latitude in the degree. The numbers resulting from the addition of the secants of the successive minutes reckoned from the equator form a scale of meridional parts, which is given in all books of navigation. Landsmen may obtain a good general idea of the construction of Mercator's chart from the article on the subject in the *Penny Cyclopædia*. [MAP; PROJECTION.]

Mercenaries (Lat. mercenarius). The name given to soldiers who sell their services for money. In the earlier periods of the Greek republics, as in that of Rome, all the citizens were bound to serve, as such, and without pay; and there was nothing like a standing army. Such a force was, however, naturally maintained by the Greek tyrants; and the Athenians, in the time of their wealth, for a different reason hired foreigners into their service, whence the term ξένοι or *strangers* became almost equivalent to that of mercenary. The Roman citizens, it is said, began to receive pay as soldiers during the war which ended in the destruction of Veii; but mercenaries in the strict sense of the word were not employed by them till a much later period of their history. [CONDOTTIERI.]

Mercuriale. The first Wednesday after the great vacation of the parliaments, under the old French régime. On that day they met to discuss grievances and deficiencies, and to reprimand members for misconduct. Hence, an harangue of reproof is popularly termed in French a *mercuriale*.

Mercurialis. A genus of common weeds of the Euphorbiaceous order, and having poisonous qualities. *M. perennis* is called Dog's Mercury.

Mercurius Dulcis. An old Pharmaceutical term for Calomel.

Mercury (Lat. mercurius, from merx, mercari, *to traffic*). A Latin god, of commerce and gain. His festival was celebrated on May 25, chiefly by merchants, who visited his altar and well near the Porta Capena at Rome. The statue of Mercurius Malevolus on the Vicus Sobrius, where he was propitiated with milk instead of wine, held a purse in its hand. Thus there is little or nothing in common between the Latin Mercury and the Greek Hermes, with whom the later Ro[man]s identified him, although the Fetiales refused to recognise the identity. [HERMES.]

MERCURY. This metal is found in various parts of the world. Among the principal mines are those of Almaden, near Cordova, in Spain; Idria, in Carniola; Wolfstein and Morsfield, in the Palatinate; Guancavelica, in Peru. The principal ore of mercury is the *sulphide* or *native cinnabar*, from which mercury is separated by distillation, either with quicklime or iron-filings, or by simply burning off the sulphur. Mercury occurs *native*, in small globules, generally dispersed through the sulphide. It is also found as a *chloride*, *iodide*, and *selenide*, but these are rare ores: in combination with silver it constitutes *native amalgam*.

Mercury is a brilliant silvery-white fluid metal, whence the terms *hydrargyrum* (ὕδωρ ἄργυρος) and *quicksilver*. In chemical formulæ it is represented by Hg, and by the atomic equivalent 100. It is liquid at all common temperatures, solid at $-40°$, and contracts at the moment of congelation. It boils at about 660°, but it emits vapour at all temperatures above 40°. Its specific gravity at 60° is 13·56, but in the solid state it exceeds 14. The specific gravity of mercurial vapour is 6·976. When mercury is pure, it is not affected by agitation in contact with air. When rubbed with sugar, chalk, lard, conserve of roses, &c., it is reduced to a grey powder, which consists of minute mercurial globules, blended with the foreign body. In well-made mercurial ointment, or blue pill, which is mercury rubbed down with conserve of roses, these globules should not be discernible by the naked eye.

Mercury and oxygen combine in two proportions, and form two oxides, both of them salifiable: a dioxide or suboxide, composed of 200 mercury and 8 oxygen; and a protoxide, composed of 100 mercury and 8 oxygen. The suboxide is obtained when finely levigated dichloride of mercury (calomel) is triturated with excess of lime water. It is a black powder, resolved by light or by heat into metal and oxide. It forms a distinct class of salts, which give black precipitates with the caustic alkalies.

The *protoxide* or *red oxide* is produced by heating mercury in a long-necked flask, open to the air, nearly to its boiling point. It becomes slowly coated with reddish brown scales and crystals, and is ultimately converted into a red crystalline substance, called in old pharmaceutical works *precipitatum per se* or *calcined mercury*. It may also be obtained by heating nitrate of mercury; and it is thrown down in the form of a yellow powder when potash or soda is added to a solution of corrosive sublimate, or of nitrate of mercury. In this precipitated state it possesses certain properties in regard to solvents, which distinguish it from the crystalline oxide, of which it is considered an allotropic modification.

Mercury and *Chlorine* also combine in two proportions, and form a subchloride, and a chloride, formerly called *protochloride and bi-*

chloride; the old terms *calomel* and *corrosive sublimate* applied to these chlorides are distinctively convenient.

Subchloride of mercury, or calomel, composed of 200 mercury and 36 chlorine, is generally made by sublimation, from a mixture of the sulphate of the suboxide with common salt. The calomel vapour is received into a capacious condenser, in which it is deposited in a pulverulent form: it is afterwards carefully levigated, and washed in large quantities of distilled water.

Calomel is tasteless, and insoluble in water. Its specific gravity is 7·14. At a heat somewhat below redness, it rises in vapour, without previous fusion; but it fuses when heated under pressure. The density of its vapour is 8·2. [CALOMEL.]

Chloride of Mercury or *Corrosive Sublimate*, composed of 100 mercury and 36 chlorine (Hg Cl), is made by exposing a mixture of chloride of sodium and sulphate of mercury to heat in a proper subliming vessel; *corrosive sublimate* rises, and *sulphate of soda* is the residue; $HgO,SO_3 + NaCl = NaO,SO_3 + HgCl$. Chloride of mercury has an acrid nauseous taste, leaving a permanent metallic and astringent flavour upon the tongue: it is a powerful corrosive poison. Its specific gravity is 5·4. It is usually met with either in the form of heavy white semi-transparent and imperfectly crystallised masses, or in powder. It is soluble in about 20 parts of cold, and 2 of boiling water; and as the solution cools, it deposits quadrangular prismatic crystals. It dissolves in 3 parts of alcohol and in 4 of ether. When heated, it fuses and evaporates in the form of a dense white vapour, powerfully affecting the nose and mouth: the density of this vapour is 9·4: it is condensed in prismatic crystals on cold surfaces.

Corrosive sublimate is either decomposed by, or combines with, many organic bodies; some of them convert it into calomel, others enter into combination with it, forming permanent compounds. The applications of it to the preservation of anatomical preparations, and to the prevention of dry rot, illustrate these actions. The efficacy of a mixture of white of egg and water, in preventing or mitigating the poisonous effects of this substance, depends upon its direct combination with albumen. [DRY ROT.]

The *Iodides* and *Bromides* of mercury correspond in atomic composition with the chlorides. The iodide (= Hg I) is of a scarlet colour, but not sufficiently permanent for use as a pigment. The red *sulphide* of mercury has been above adverted to as the principal native compound or ore of this metal; it is largely manufactured, generally by heating mixtures of mercury and sulphur, and sometimes in the humid way by precipitation: that made in China is especially esteemed on account of its colour, but as a pigment it is not permanent. [CINNABAR; VERMILION.]

Cyanide of mercury is occasionally resorted to as a source of hydrocyanic acid, and the *Fulminate* is largely manufactured for use in percussion caps. [FULMINATING MERCURY.]

Large quantities of mercury are used in the separation of gold and silver from their ores, and it is a metal of considerable importance in reference to its therapeutical applications. It is employed in the construction of barometers, thermometers, and some other philosophical instruments, and more especially in the manufacture of looking-glasses or mirrors, the *silvering* of which is effected by the application of *an amalgam of mercury* to the polished surface of the glass. The process is performed as follows:—

A single and perfect sheet of pure tinfoil, of proper thickness, and somewhat larger than the plate of glass, is spread upon a perfectly plane table of slate or stone: mercury is then poured upon it, and rubbed upon its surface by a hare's foot, or a ball of flannel or cotton, so as to form a clean and bright amalgam; upon this, an excess of mercury is poured, until the metal has a tendency to run off. The plate of glass, previously made quite clean, is now brought horizontally towards the table, and its edge so adjusted, as, by gradually and steadily sliding it forward, to displace some of the excess of mercury, and float the plate as it were over the amalgam, the dross upon its surface being pushed onwards by the edge of the glass, so that the mercury appears beneath it with a perfectly uniform, clean, and brilliant reflecting surface. Square iron weights, of 10 or 12 lbs. each, are then placed side by side upon the surface of the plate, so as entirely to cover it, and press it down upon the amalgamated surface of the tin; in this way the excess of mercury is partly squeezed out, and the amalgam is made to adhere, by crystallisation, firmly to the glass. The mercury, as it runs off, is received into a channel on the side of the table, which is slightly inclined to facilitate the drainage, and in about 48 hours the weights are taken off and the plate is carefully lifted from the table and set nearly upright, by which the adhering mercury gradually drains off, and the brilliant amalgam remains, perfectly and uniformly adhering to the glass.

The annual imports of mercury into this country are about 2,200,000 lbs., chiefly from Almaden; of this quantity only about one-eighth is retained for home consumption, the rest being exported chiefly to South America, the United States, and the East Indies, with smaller quantities to Russia, Belgium, &c.

MERCURY. In the Solar System, the planet nearest the sun. The mean distance of Mercury from the sun is 0·3870981, the earth's mean distance being taken as unit; it is consequently little more than a third of the earth's distance, and equal to about 36,000,000 miles. His mean sidereal revolution is performed in 87·969,258 mean solar days, and his successive oppositions or conjunctions take place at intervals of 115·877 mean solar days.

The orbit is inclined to the ecliptic in an angle of 7° 0′ 9″; and its eccentricity is greater than that of any other of the old planets, being 0·205,515, the major axis being unit. Mercury being an inferior planet always appears in the neighbourhood of the sun; his greatest elongation, or angular distance from the sun, amounts only to 28° 48′; so that he is very seldom, when at his greatest distance from the earth, visible to the naked eye, and then only at sunrise or sunset. His apparent diameter varies from 5″ at his superior conjunction to 12″ at his inferior conjunction when nearest the earth. At a distance equal to the mean distance of the sun from the earth, the apparent diameter is 6·9″. His true diameter, compared with that of the earth taken as unity, is ·398, or about 3,140 miles. On account of the smallness of the planet and its proximity to the sun, it is difficult to distinguish any features on the surface. Mercury, like the moon and Venus, exhibits phases; and the planet is supposed to revolve about its axis in 24h. 5m. 28s.; but the evidence on which this rests is far from conclusive. Mercury is sometimes seen to pass over the sun's disc. This can only happen when he is in one of his nodes nearly at the same time that he is at his inferior conjunction. The phenomena are of more frequent occurrence than the transits of Venus, but of far less astronomical importance. The two next transits will be visible in this country, and will occur at the following dates: 1868, Nov. 4; 1878, May 6. [PLANET.]

Merganser. [MERGUS.]

Merger. In Law, the destruction of a lesser estate in lands and tenements by the acquisition of a greater estate in the same, immediately succeeding, by the same party and in the same right. Thus an estate for years will merge in an estate for life, if there be no other intervening estate; and an estate for life in an estate of inheritance. So, if a landowner becomes entitled to a sum of money charged on the land, the charge will generally be merged. There is no merger of an estate tail.

Mergus (Lat. *a diver*). A Linnæan genus of Anserine birds, characterised by a beak thinner and more cylindrical than that of the ducks, and with each mandible armed at its margins with small pointed teeth directed backwards, like those of a saw: the upper mandible is curved downwards, at its extremity. The goosander (*Mergus serrator*) and the merganser (*Mergus Merganser*) are examples of this genus.

Mericarp (Gr. μερίς, *a portion*, and καρπός, *fruit*). In Botany, the half of the double fruit of an umbellifer.

Meridian (Lat. meridies, *mid-day*). In Astronomy, a great circle of the sphere passing through the poles of the earth's axis and the zenith of the spectator. It is the circle on which the latitudes of places are reckoned, commencing from the equator, which it intersects at right angles. [DEGREE.]

Meridian Altitude. The altitude, or height above the horizon, of any celestial object, when it crosses the meridian of a place.

Meridian, First. The meridian from which longitudes are reckoned. The choice of the first meridian is entirely arbitrary; and most nations reckon the longitudes from their capital or meridian passing through their principal observatories. Thus, in English works, the longitude is reckoned from Greenwich; in French, from Paris; in Russian, from St. Petersburg, &c. Ptolemy employed the Canary Islands, the French formerly reckoned from Ferro, and the Dutch from the Peak of Teneriffe. Mercator chose the island Del Corvo. [LONGITUDE.]

Meridian of a Globe or **the Brass Meridian.** A graduated circular ring, within which an artificial globe is suspended and revolves, and by means of which it is connected with the frame bearing the horizontal scale. Meridian lines are also traced on the globe itself, usually at 15° distance, or a difference of longitude corresponding to an hour of time. It is probable that these, with the parallels of latitude, suggested to Descartes the idea of *co-ordinates*, which he applied so successfully to connect algebra with geometry.

Meridian Line. A line traced on the surface of the earth, coinciding with the intersection of the meridian of the place with the sensible horizon.

Merino Sheep. A breed of sheep till lately peculiar to Spain, but now reared in Saxony, and particularly in Australia, chiefly for the superior fineness of their wool. The word *merino* signifies an overseer of pasture lands, and is applied to this breed of sheep, because, in Spain, they are kept in immense flocks, under a system of shepherds, with a chief as a head, and with a general right of pasturage all over the kingdom. The best flocks of Spanish merinos are found in Leon and Castille; of the Saxon variety, at Stolpen and Rochsburg; but merinos are to be found in North America, the Cape of Good Hope, and above all in New South Wales, which has become one of the principal wool-growing countries in the world. There are one or two flocks of pure merinos in this country; but the unfitness of the climate, and the high prices both of wool and of mutton discourage any attempt to displace the larger native breeds. [SHEEP.]

Merlon (Fr.). In Fortification, the part of the parapet between two embrasures.

Mermaid (Ger. meer, *sea*, and magd, *maid*). A fabulous creature; the fore part woman, the hinder half fish. The animals which, viewed at a distance, may have originated the idea of mermen and mermaids, are the cetaceous *dugong* and *manatee*: these have their fore fins rudely fashioned like arms and hands, and terminate behind in a fish-like tail. The nipples are pectoral; and they are often seen ascending to the surface to breathe, clasping their suckling young to the breast.

Meropidans. The family of Insessorial birds of which the bee-eater (*Merops*) is the type.

Meros (Gr.). In Architecture, the plane face between the channels in the triglyphs of the Doric order.

Meroxene. A name given to the brilliant crystals of brownish-green Mica (*Biotite*) from Vesuvius.

Merulidans. The family of Dentirostral perchers of which the thrush (*Merula*) is the type. [THRUSH.]

Merulius. A genus of Fungi well known as comprising the species which produces Dry Rot. This plant is called *M. lacrymans*. Coniferous wood is very liable to be attacked by this destructive agent, but its attacks are not confined to such wood, other timber when it falls in its way being equally liable to destruction. It will sometimes penetrate even thick walls, to the destruction of the mortar. In wine-cellars it destroys shelves and laths, and creeps amongst the sawdust used for packing, ultimately attacking the corks and spoiling the wine. Hence sawdust should not be used in cellars liable to this pest; and if wood is any way used, it should be kyanised. [DRY ROT.]

Mesembryaceæ (Mesembryanthemum, one of the genera). A rather extensive but not very important order of perigynous Exogens of the Ficoidal alliance. They are succulent herbs, abundant in South Africa and distinguished by their numerous conspicuous petals, and several consolidated carpels. Many of them are very beautiful.

Mesembryanthemum (Gr. μέσος, *the middle*; ἔμβρυον, *embryo*; and ἄνθος, *a flower*). A very large genus of succulent Cape plants, of which many species are conspicuous for the beauty of their flowers, which expand in sunshine, and close up in gloomy weather. They are chiefly interesting on account of the hygrometric quality of their fruit, which when wetted opens out into numerous radiating valves, and when dry contracts with force into a compact and apparently solid body. This fruit is sometimes called the Fig-marigold.

Mesencephalon (Gr. μέσος, and ἐγκέφαλος, *brain*). The natural primary division of the brain, which is usually encompassed by the parietal segment of the cranium, and consists of the lobe of the third ventricle, the optic lobes, with the appendages called the *conarium*, *hypophysis*, and in fishes the *hypoaria*. Chaussier gave the term *mesocephale* to an artificial combination of the pons varolii with the optic lobes, dissociating the one from the medulla oblongata and cerebellum, and the other from the lobe of the third ventricle. By some anthropotomists the term *mesocephalon* is used synonymously with that of *pons varolii*.

Mesentery (Gr. μεσέντερον). The membrane by which the intestines are attached to the vertebræ; it is formed of a duplicature of the peritonæum, and supports the nerves and vessels of the intestines.

Mesitylene. A hydrocarbon $= C_{8}H_{12}$, produced by the action of sulphuric acid upon acetone.

Meslin (Old Fr. mesler, *to mix*). A mixture of various kinds of grain.

Mesmerism. [MAGNETISM, ANIMAL.]

Mesne Process. Such process as intervenes between the beginning and end of a suit. It is opposed to final process, or that which takes place by way of execution after judgment. Imprisonment for debt on mesne process was formerly effected on the bare affidavit of one person, stating that another owed him 20*l*., but except as regards absconding debtors was abolished by the Act 1 & 2 Vict. c. 110. [ARREST.]

Mesne Profits. The yearly rents, &c. of land held illegally, which are recoverable in an action of trespass by the lawful owner after he has recovered possession of the land.

Mesocarp (Gr. μέσος, and καρπός, *fruit*). In Botany, that part of a pericarp which lies between the epicarp and endocarp.

Mesocolon (Gr. μεσόκωλον). The mesentery of the colon: it is an extensive duplicature of the peritonæum.

Mesolabe (Gr. μεσολαβέω, *to take by the middle*). An instrument employed by the ancients for finding two mean proportionals between two given lines; these were required in the problem of the duplication of the cube. (See Eutocius *On the Works of Archimedes*, and the third book of Pappus.)

Mesolite (Gr. μέσος, and λίθος, *stone*; because it is intermediate between Natrolite and Scolezite). A lime-and-soda Mesotype.

Mesophlœum (Gr. μέσος, and φλοιός, *bark or rind*). In Botany, the cellular layer of bark overlying the liber, and underlying the epiphlœum, i.e. the layer immediately beneath the epidermis.

Mesophyllum (Gr. μέσος, and φύλλον, *a leaf*). In Botany, the parenchymatous tissue forming the fleshy part of a leaf between the upper and lower integuments.

Mesothorax (Gr. μέσος, and θώραξ, *the chest*). In Entomology, the posterior segment of the alitrunk, which bears the posterior pair of wings and the third or posterior pair of legs.

Mesotype (Gr. μέσος, *middle*, and τύπος, *type*). The name given by Haüy to Natrolite, because the primary form of its crystals is intermediate between Analcime and Stilbite.

Mesoxalic Acid. An acid obtained by boiling a saturated solution of alloxanate of baryta, which is thus resolved into *mesoxalate of baryta*, and other products. This acid is crystallisable, and very sour and soluble. Its formula is $C_6H_2O_{10}{\cdot}2HO$.

Mesozoic (Gr. μέσος, and ζωή, *life*). The name given by Professor Phillips to the middle of the three great geological periods, more usually denominated SECONDARY. The mesozoic group includes (1) the new red sandstone or triassic, (2) the lias, (3) the great series of the oolites, (4) the Wealden, and (5) the (

series, and is of great importance in England, owing to the many useful minerals which it yields. It is also rich in fossils, being remarkable for reptiles' bones, many of them indicating animals of singular forms and proportions. It is not the case, however, as once supposed, that reptiles first appear in mesozoic rocks, as they have been recently found in coal measures. Neither is this middle period without representative forms of animals of still higher organisation; as quadrupeds certainly, and birds probably, existed during the whole of it. The minerals include, besides limestones and cement stones very rich and extensive deposits of iron-ore, and abundant stores of rock salt and salt springs.

Mespilus (Lat.; Gr. μέσπιλον, *the Medlar-tree*). The botanical name of the genus of the Medlar. The common medlar is called *Mespilus germanica*. [MEDLAR.]

Mess (Lat. mensa, *a table*). In Military language, the public dinner prepared for the officers of a regiment or detachment, and to the support of which they are bound to contribute a portion of their pay. Generally speaking, only married officers are exempted from contributing to, and dining at, the mess; the rest preside over it in rotation, without respect to military rank. There is a small government allowance in aid of the expenses of the officers' mess. Messes for sergeants have now been universally established.

MESS. In the Royal Navy, the general meeting of the officers at the meals. In large ships there are the ward-room mess, gun-room mess, midshipmen's mess, and engineer's mess. In ships of the frigate class and smaller vessels, the ward room is wanting. The sailors are also divided into messes of eight to twelve men each, among whom one acts as cook and messman. Each officers' mess has its steward, who serves as caterer.

Messenger (Fr. messager, from Lat. missus, *sent*) or **Voyol.** In Naval language, a hawser or small cable of about sixty fathoms in length, wound round the capstan, and employed to transmit the capstan's power to the great cable, which from its non-pliability would fail to bite so well on the barrel. As the messenger is wound on at one end it is wound off at the other, the loose end being nipped on to the cable lower down, so as to make the action continuous.

Messengers, King's. Certain officers employed in the secretary of state's department to convey despatches, either at home or abroad. They were formerly employed in serving the secretaries' warrants for the apprehension of parties charged with high treason, or other grave offences; and in such cases it was not unusual for them to detain their prisoners at their own houses. In the year 1713 the ambassador of the emperor of Morocco was taken into custody by a king's messenger, and released only after a lapse of six months.

Messiad. The name given to the only modern epic poem of Germany; the subject of which is the sufferings and triumph of the Messiah. It is written in hexameter verse, for which the German is, perhaps, better fitted than any modern language, and consists of twenty books. The publication of this poem procured for its author a great reputation; but posterity does not appear to sanction the high award pronounced on it by contemporaneous writers. The reputation of Klopstock among his own countrymen rests chiefly on his Odes; and it must be admitted that in all those parts of his epic poem into which a lyric spirit could be infused—in other words, whenever the feelings or the sympathies were to be excited—there are few poets, either ancient or modern, to whom he deserves to be postponed; but, on the other hand, the dignity and sublimity of his sentiments are not unfrequently disfigured by the pedantry and affectation of his style, and the tediousness of his episodes.

Messiah. An old Hebrew word, signifying the anointed or sacred, corresponding with the Greek word χριστός; and in this sense applied by Christians to the Saviour, as it was anciently applied by the Jews to their prophets, priests, and kings, who were all anointed when they assumed their office.

Messuage (Mod. Lat. messuagium). In Law, a messuage is said to be properly a dwelling-house with a small portion of land adjacent. It is now one of the general words used in the legal description of dwelling-houses with the land attached.

Mestino. In Spanish America, the child of a Spaniard or creole and a native Indian. [MULATTO.]

Metabolians (Gr. μεταβολή, *change*). A subclass of insects, including all those which undergo a metamorphosis.

Metacarpal (Gr. μετά, *between*; καρπός, in the sense of *the wrist*). Belonging to the metacarpus, or that part of the hand which is between the wrist and fingers.

Metacentre. A term first applied by Bouguer to a certain point of a floating body upon the position of which the stability of the body depends. [HYDROSTATICS.]

Metacetone (Gr. μετά, indicating *change*; and acetone). One of the products formed during the distillation of a mixture of one part of starch or sugar with eight of quick lime; it is a colourless liquid, insoluble in water, but soluble in alcohol and ether, and of an agreeable odour. Its formula is C_6H_5O. It is converted by oxidising agents into *metacetonic* (*propionic*) acid $= C_6H_5O_3 + HO$.

Metachlorite. A mineral resembling Chlorite, found in green aggregated crystals at Büchenberg in the Harz.

Metagallic Acid. When gallic acid is rapidly heated up to about 480°, carbonic acid and water are evolved, and a black product remains soluble in the alkalies, and forming insoluble compounds with many of the metallic oxides. This product has been termed *metagallic acid*.

Metagenesis (Gr. *μετά*, indicating *change*; and *γένεσις*, *birth*). The changes of form which the representative of a species undergoes in passing, by a series of successively generated individuals, from the egg to the perfect or imago state. It is contradistinguished from *metamorphosis*, in which those changes are undergone by the same individuals. The following is an example of metagenesis: The egg of the Medusa is developed into a *polype* which, assuming a form called *Strobila*, separates into numerous individual young Medusæ. The larval polype propagates other similar polypes by gemmation, each of which becomes a *Strobila*, and is resolved into numerous Medusæ. Thus there is a successive production of procreating individuals from a single impregnated ovum of a Medusa, according to the law of Parthenogenesis.

Metallic Colours. A term sometimes applied to pigments of mineral origin, to distinguish them from colours derived from the animal and vegetable kingdoms. Many metals yield coloured compounds capable of being employed as pigments; but chromium, copper, lead, and iron are especially distinguished for the valuable colours which they produce.

Metallic Tractors. Towards the end of the last century, Dr. Elisha Perkins, of Norwich in Connecticut, introduced a method of treating diseases by drawing over the affected part two small metallic rods made of different metals, which he called *metallic tractors*, and the operation was called *tractoration*. The use of tractors has been called *Perkinism*.

Metallochromes (Gr. *μέταλλον*, *metal*, and *χρῶμα*, *colour*). When very thin films of peroxide of lead are deposited by electrolytic action upon polished steel plates, they give rise to those beautiful prismatic tints which Nobili first described under the above name.

Metalloids (Gr. *μέταλλον*, and *εἶδος*, *form*). A term sometimes applied to the inflammable non-metallic bodies, such as sulphur, phosphorus, &c., or sometimes to all the non-metallic elements. The metallic bases of the fixed alkalies and alkaline earths were at one time called metalloids, in consequence probably of their low specific gravity.

Metallurgy (Gr. *μεταλλουργέω*, *I smelt or work metals*). The art of separating metals from their ores. Some of the principal metallurgic processes are described under the respective metals. Dr. Percy's *Metallurgy* is the most comprehensive English work upon the subject, and Phillips's *Metallurgy* is a useful compendium. See also Pélouze and Frémy, *Chimie Inorganique*, ii., and Dumas' *Chimie appliquée aux Arts*.

Metals (Gr. *μέταλλον*). The metals constitute a numerous and important class of elementary bodies: they are characterised by a distinctive lustre, by their opacity, and by their high conducting powers in respect to heat and electricity. They amount (including, however, some of doubtful character) to 53 in number, and are enumerated in the following table, together with the abbreviations or *symbols* by which they are usually designated in works on chemistry, and their *atomic weights* in reference to hydrogen as unity:—

Potassium	K	39	Copper	Cu	32
Sodium	Na	23	Lead	Pb	104
Lithium	Li	7	Thallium	Tl	204
Cæsium	Cs	133	Bismuth	Bi	213
Rubidium	Rb	85	Cobalt	Co	30
			Nickel	Ni	30
Barium	Ba	69	Chromium	Cr	26
Strontium	Sr	44	Vanadium	V	68
Calcium	Ca	20	Tungsten	W	92
Magnesium	Mg	12	Tantalum	Ta	138
			Niobium	Nb	98
Aluminum	Al	14	Molybdenum	Mo	48
Glucinum	G	7	Uranium	U	60
Zirconium	Zr	34	Tellurium	Te	64
Thorium	Th	60	Titanium	Ti	24
Yttrium	Y	32	Antimony	Sb	122
Erbium	Er	?	Arsenic	As	75
Terbium	Tb	?			
Cerium	Ce	46	Mercury	Hg	100
Lanthanum	La	44	Silver	Ag	108
Didymium	Di	48	Gold	Au	197
			Platinum	Pt	99
Iron	Fe	28	Palladium	Pd	54
Manganese	Mn	28	Rhodium	Ro	52
Zinc	Zn	32	Ruthenium	Ru	52
Tin	Sn	59	Osmium	Os	100
Cadmium	Cd	20	Iridium	Ir	99

The first five of the metals upon the preceding list are distinguished as the metals of the alkalies; their oxides are powerfully alkaline; they have an intense affinity for oxygen, and decompose water at all temperatures. The next four metals are the bases of the alkaline earths; with the exception perhaps of magnesium, they also decompose water at all temperatures. The ten succeeding metals, with the exception of aluminum, have been but imperfectly examined; they are generally designated as the bases of the earths. The following twenty-two metals have been sometimes divided into those which form basic oxides, and those which form acids; and they have been separated into other distinctive groups, having reference to the action of acids upon them, to their action upon water at high temperatures, and to the isomorphism of their salts; these characters, however, are not sufficiently definite; and as regards the basic or the acid character of their compounds with oxygen, several of them form compounds belonging to both classes. The last nine metals include those which have been particularly designated as noble metals; they are not changed by air or by water, and their affinity for oxygen is comparatively feeble: to some of these properties, however, osmium forms an exception.

Physical Properties.—A high degree of *lustre* is one of the leading physical characters of the metals, the colour of the light which they reflect varying with the nature of the metal and the number of reflections to which it has been subjected. In most cases it is nearly white, grey, or bluish: from gold it is yellow, and from copper red; but the intensities of these colours may be greatly increased by repeated reflection.

The *opacity* of metals is such, that when in very thin leaves, they transmit no light. Gold is so far an exception, that when beaten into leaves of a 200,000th of an inch in thickness it transmits green light, and if alloyed with silver, blue light. There are also other means by which extremely thin metallic films may be obtained, and which often exhibit a certain amount of transparency.

Hardness—Brittleness.—Few of the metals, when pure, are very hard; they are generally softer than steel. Lead may be scratched by the nail; and potassium at 60° is softer than wax. Some, such as antimony, arsenic, and bismuth, may be easily pulverised: others are brittle at one temperature, but malleable and ductile at another. Zinc, for instance, which at common temperatures is comparatively brittle, may be rolled and drawn into wire when heated up to 300°.

Malleability, or the capacity of being extended by hammering or rolling, belongs to some of the metals in a very remarkable degree. Common gold-leaf, for instance, is not more than a 200,000th of an inch in thickness; and three grains of the metal are sufficient to cover a square foot. Silver, copper, and tin, also admit of great extension under the hammer. In hammering and rolling, some of the metals become so hard and brittle as to require occasional annealing; in these cases they give out much heat. The following is the order of malleability: gold, silver, copper, aluminum, tin, cadmium, platinum, lead, zinc, and iron.

Ductility.—The malleable metals are also *ductile*; i.e. they admit of drawing out into wire. In this respect, gold, silver, platinum, and iron stand at the head of the list. A grain of gold may be drawn into 500 feet of wire. A wire of platinum, not exceeding a 30,000th of an inch diameter, has been obtained by placing it in the axis of a small cylinder of silver, and then drawing the compound wire in the usual way, and afterwards dissolving off the silver by nitric acid. The order of ductility is as follows: gold, silver, platinum, iron, copper, aluminum, zinc, tin, and lead.

Tenacity, or the power of supporting a weight without breaking, is an important property of the metals. Iron is at the head of the list, and lead at the bottom; but the respective tenacities are much influenced by the temperature at which the comparisons are made, the manner in which they are tested, and more especially by the process of annealing. A wire of unannealed iron, which sustained a weight of 26 lbs., only bore 12 lbs. after having been annealed; and a wire of copper which sustained 22 lbs. before annealing, was broken by 9 lbs. after annealing. The following metals are arranged in the order of their tenacities: iron, copper, palladium, platinum, silver, gold, zinc, tin, lead. The tenacity of iron compared with lead is as 25 to 1.

In the following table the figures represent the number of pounds required to break wires one-tenth of an inch in diameter:—

Lead	27·7	Silver	187·1
Tin	34·7	Platinum	274·3
Zinc	109·8	Copper	302·2
Gold	150·7	Iron	549·5

The tenacity of a metal, with few exceptions, decreases in proportion as its temperature increases; but iron, though less tenacious at 212° than at 32°, is more so at 890° than at 212°.

Crystallisation.—Metals are susceptible of assuming the crystalline form. With many, this may be effected by fusion and slow cooling, and especially by suffering the melted metal to concrete externally, and then perforating the solid crust, and pouring out the liquid interior. The cavity so formed will be then lined with crystals: this mode of proceeding answers extremely well with bismuth, which furnishes a congeries of cubic crystals. When the metals are precipitated by each other, they often crystallise during their deposition, as in the precipitation of silver by mercury, and in that of lead by zinc. A stick of phosphorus immersed in a solution of silver becomes incrusted with metallic crystals. Gold is occasionally deposited in a crystalline form, from its ethereal solution. During the electrolysis of metallic solutions, especially when low powers are employed, beautiful crystals are also occasionally obtained.

The crystalline structure of a metal materially affects some of its other physical properties. Copper, silver, and even gold, become comparatively hard and brittle when in a crystalline condition; and the most brittle metals are those which most readily assume the crystalline form, such as bismuth and antimony. Even iron, which in one condition is fibrous, tough, and tenacious, becomes relatively brittle when it assumes even an approach to a crystalline structure; and this change in its condition is sometimes the result of changes of temperature, and shows itself in bars and axles which have been subjected to protracted friction and vibration.

Specific Gravity.—The specific gravities of the metals, or their relative densities, as compared with distilled water at the temperature of 60°, are shown in the following table; they include the lightest and the heaviest solids. The metal lithium is the lightest, and platinum the heaviest, of all known solids.

Osmium	21·40	Manganese	8·0
Platinum	21·15	Iron	7·8
Iridium	21·15	Tin	7·2
Gold	19·3	Zinc	7·1
Tungsten	17·6	Columbium	6·0
Mercury	13·5	Antimony	6·7
Rhodium	12·0	Tellurium	6·6
Palladium	11·8	Arsenic	5·9
Ruthenium	11·3	Chromium	5·9
Lead	11·4	Titanium	5·3
Thallium	11·8	Aluminum	2·6
Silver	10·5	Strontium	2·5
Bismuth	9·8	Glucinum	2·1
Cobalt	8·9	Magnesium	1·74
Copper	8·9	Calcium	1·5
Nickel	8·8	Sodium	0·97
Molybdenum	8·6	Potassium	0·86
Cadmium	8·6	Lithium	0·59

Relation of Metals to Heat.—The changes of *bulk* which metals undergo with changes of *temperature* are relatively greater than those of other bodies; but each metal has its peculiar rate of expansion, as shown in the following table, in which 1,000,000 parts of each metal are assumed to be heated from 32° to 212°:—

	Increase in length	Increase in bulk
Platinum . .	1 in 1131	1 in 377
Palladium . .	1 in 1000	1 in 333
Antimony . .	1 in 923	1 in 307
Iron . . .	1 in 846	1 in 282
Bismuth . .	1 in 718	1 in 239
Gold . . .	1 in 682	1 in 227
Copper . .	1 in 582	1 in 194
Silver . .	1 in 524	1 in 175
Tin . . .	1 in 516	1 in 172
Lead . . .	1 in 351	1 in 117
Zinc . . .	1 in 340	1 in 113

The expansion of glass is nearly the same as that of platinum, and hence wires of that metal may be welded into fused glass without inconvenience; but if we substitute a wire of another metal, its different rate of contraction tends to break the glass as it cools. So also a compound bar of iron and copper, or of platinum and silver, formed by riveting strips of the metals to each other, though it remains straight at the temperature at which they were riveted, becomes warped or curved when heated or cooled. The metallic thermometer, and the compensation pendulum or balance-wheel as applied to clocks and watches, are illustrations of the same principle.

The *force* exerted in this act of metallic expansion is so considerable as often to produce injurious effects when not adequately provided for, as in railways, bridges, water and gas pipes, and in the beams, columns, and roofs of buildings.

The expansion of a metallic bar has been successfully applied as a means of measuring high temperatures, as in *Daniell's pyrometer.*

That the metals are excellent *conductors of heat* is learnt by the rapidity with which heat passes from one end to the other of a metallic bar; and that the different metals thus transmit heat with different degrees of facility, is shown by comparative experiments. If, for instance, two similar bars of silver and of platinum be heated at one end, the silver will be more rapidly heated throughout than the platinum. Gold, silver, and copper are among the best conductors; then come iron, zinc, and tin; and lastly, lead. A consequence of this property of the metals is, that they communicate and abstract heat more readily than other bodies; that they feel hotter and colder than wood, or other bad conductors, though of the same temperature. If the thermo-conducting power of gold be assumed as =100, that of silver will be about 98, of copper 90, of iron 38, of tin 30, and of lead only 18.

The *polished metals* are remarkable for their low power of emitting and of receiving *radiant heat.* A polished metallic vessel filled with hot water, is a long time in cooling; and such a vessel containing cold water, and placed before the fire, is a long time in acquiring heat. When the polish is taken off, the radiating and receptive powers of such vessels are increased; but under all circumstances the metals are bad radiators. If we compare the radiating power of a surface coated with lampblack, with that of polished gold, silver, copper, or tin, it is nearly as 100 to 12; and all tarnished metals radiate better than those which are bright and clean.

Fusibility.—The metals are all susceptible of fusion by heat, but the temperatures at which they liquefy are extremely various. At higher temperatures than those required for their fusion, the metals are *volatile,* and many of them may be distilled in close vessels. Mercury is volatile at temperatures above 40°. A piece of gold leaf suspended over it in a stopped bottle becomes slowly whitened by amalgamation. Cadmium, potassium, sodium, tellurium, zinc, and magnesium, are volatile at a red heat, and arsenic below a red heat. Gold and silver are converted into vapour when exposed to intense heat; and most of the other metals evaporate under similar circumstances.

Although the melting points are mostly mentioned under the heads of the respective metals, it will be convenient to give in this place a table showing how some of the more important metals differ from each other, in regard to the temperature at which they pass from the solid to the liquid state. The metals are here arranged in two groups: 1, those which are fusible *below* a red heat (1000°); and 2, those which are fusible *above* this temperature. The metals not included in this list can be readily fused only under the oxy-hydrogen blowpipe:—

Fusible below a Red Heat.

Mercury . . .	40°	Bismuth . . .	500°
Potassium . . .	150°	Lead . . .	612°
Sodium . . .	200°	Zinc . . .	773°
Lithium . . .	356°	Antimony . .	900°
Tin . . .	442°	Calcium . .	1000°
Cadmium . . .	442°	Magnesium . .	1000°

Fusible above a Red Heat.

Aluminum . .	1750°	Gold . . .	2016°
Silver . . .	1873°	Cast iron . .	2786°
Copper . . .	1996°		

Specific Heat of the Metals.—By the term *specific heat* is meant the quantity of heat required to raise equal quantities of different substances to the same temperature. If we thus compare water with *mercury* we find that the specific heat of water being = 1·000, that of an equal *weight* of mercury is only 0·033. The specific heat of water, therefore, or, in other words, its *capacity for heat,* is very great compared with that of the metals, as shown in the following table; from which it will also be seen that the specific heat of the metals increases with their temperatures, so that it requires more heat to raise them a given number of degrees when they are at a high than when at a low temperature. The specific heats are in all cases compared with water, as = 1:—

	Between 32° & 212°	Between 32° & 572°
Iron	0·1098	0·1218
Zinc	0·0927	0·1015
Copper . . .	0·0949	0·1013
Silver . . .	0·0557	0·0611
Antimony . . .	0·0507	0·0547
Platinum . . .	0·0335	0·0355
Mercury . . .	0·0330	0·0350

Relation of the Metals to Electricity and Magnetism.—In respect to *electrical conduction*, silver is the best, and mercury the worst conductor. Assuming the electro-conduction of silver as = 100, that of copper is about 92, gold 65, zinc 24, tin 14, iron 12, lead and platinum about 8, and mercury 2. These conducting powers are remarkably influenced, in some cases, by temperature. Thus, in reference to tin, if its conducting power at 32° be = 16, at 212° it will only be = 10; so that, in general, the lower the temperature of the metal, the higher its electro-conducting power. [Magnetism, Terrestrial.] Metals which are bad conductors of electricity become most heated by an electric current, as is well shown by transmitting a current of electricity through a wire composed of alternate lengths of platinum and silver; the platinum only becomes red hot.

Magnetism.—The peculiarities of iron in respect to magnetism have been long known, as also its permanent retention by steel. When a bar of iron is suspended between the poles of a magnet, it is equally attracted by each, and places itself parallel to the magnetic axis. Some other metals are similarly affected, though in an inferior degree; but there are some which appear to be repelled by the magnetic poles, and which, when properly suspended between them, assume a direction at right angles to the magnetic axis, placing themselves *equatorially*. Faraday, who first observed these phenomena, terms such substances *diamagnetics*. He has shown that various solids, liquids, and gases include magnetic and diamagnetic substances [Magnetism]; and that, as far as the metals are concerned, they may be arranged in the following order:—

Magnetic		Diamagnetic	
Iron	Cerium	Bismuth	Silver
Nickel	Titanium	Antimony	Copper
Cobalt	Palladium	Zinc	Gold
Manganese	Platinum	Tin	Arsenic
Chromium	Osmium	Cadmium	Uranium
		Sodium	Iridium
		Mercury	Tungsten
		Lead	

Metameconic Acid. [Comenic Acid.]

Metameric (Gr. *μετά*, and *μέρος*, *part*). A term applied in Chemistry to bodies having one and the same composition and atomic weight, but yet differing remarkably in certain of their properties, probably in consequence of dissimilar molecular constitution. Thus, formiate of oxide of ethyle (formic ether) and acetate of oxide of methyle (methylo-acetic ether) may both be correctly represented by $C_6 H_6 O_4$, but the elements in each are no doubt dissimilarly grouped, as represented in the following formulæ:—

$$\left.\begin{array}{l}\text{Formiate of oxide of ethyle}\\ \quad C_4 H_5 O + C_2 H O_3\\ \text{Acetate of oxide of methyle}\\ \quad C_2 H_3 O + C_4 H_3 O_3\end{array}\right\} = C_6 H_6 O_4.$$

'Isomeric compounds, the equivalent numbers of which are identical, are said to be *metameric*.' [Isomerism.]

Metamorphic Rocks (Gr. *μετά*, and *μορφή*, *form*). The materials of the earth's crust beneath the soil are called by geologists *rock*, whether they are hard like limestone and granite, plastic like clay, or loose like sand; and of these rocks all that are not in the condition in which they were originally accumulated, must be regarded as changed, altered, or *metamorphosed*. The latter expression is technical, and means that a definite change has taken place in the structure of the material.

As, therefore, all mechanical rocks except coral limestones have originally been deposited from suspension or solution in water, and therefore in the form of mud, sand, or gravel of some kind, it becomes obvious, when we find sandstones and limestones, or compacted and bedded clays, containing bands, nodules, and crystals, that a change has passed over them. They are no longer mud, but have assumed a new existence and new conditions; in a word, they have become *metamorphic rocks*.

The term is not usually so widely extended, but it is clear that no line can be drawn. Some rocks are so little altered that we can hardly recognise the change, some are so much changed that we can hardly trace the original form. Very extensive metamorphoses can take place without obliterating the traces of organic origin.

More commonly, only those rocks are spoken of as metamorphic which show the last stage of a transition to crystalline structure, and to the condition called *plutonic* or *igneous*. Such are marbles, quartzites, slates, micaceous and other schists, and gneiss, all of these being rocks in which the evidences of original aqueous origin are nearly or entirely lost. Regarded in this light, metamorphic rocks form a class of rocks distinct from aqueous, from volcanic or recent igneous, and from plutonic or ancient igneous. So many doubtful rocks have, however, on further examination turned out to be metamorphic, that possibly all rocks not actually showing marks of igneous agency may be found to belong to this large and important group.

Metamorphic rocks, of which calcareous rock is the basis, are very varied. Actually unaltered limestone hardly exists as a rock, for this mineral (carbonate of lime), associated and mixed up with many foreign substances, very readily undergoes change, and tends to separate itself into concretions when buried with other minerals and water. The common chalk or limestone mud is not much altered, but it often contains shells converted into flint and veins with crystalline calc spar or crystalline silica.

Coral limestone not only has the interstices between the corals filled up so that all are cemented into a solid mass, but is often so far altered as to be partly crystalline. Shell limestones in the same way are compacted, cemented, crystallised, and sometimes parts of them are completely replaced by other mineral. Sandstones also are cemented, cracked, and the cracks filled with matter more or less crystalline. In these cases the marks of mechanical origin are by no means obliterated. But where fossils occur in rocks, it is often not the actual and original animal product that we see, but something like it, i.e. something into which it has been changed. It is not necessary here to discuss how or why these changes have taken place; it is enough to point out the significant fact. Change goes on whenever any mixture of mineral matter is buried in the earth and left exposed to ordinary influences. If buried deeply by the subsequent accumulation of other deposits, and thus brought within the influence of a more equable temperature, the changes that take place are extensive and fundamental.

In this way a complete conversion has sometimes taken place, fossiliferous strata having exchanged an earthy for a highly crystalline texture for a distance of a quarter of a mile from their contact with granite. That the mere contact of granite near the earth's surface has no power to do this, is clear from the fact that many limestones have rested unaltered close to granite for an indefinite period. Besides the conversion mentioned, dark limestones full of shells and corals have been turned into white statuary marble, and hard clays into claystone, mica slate, and hornblende slate, fossiliferous at a distance, but losing all trace of fossil near the metamorphosed rocks.

Metamorphoses (Gr. μεταμόρφωσις, *change of form*). The changes of form which the representative of a species undergoes in a single individual. The term has practically been restricted to the instances in which the individual, during certain phases of the change, is free and active, as in the grub of the chaffer, or in the tadpole of the frog.

Metaphor (Gr. μεταφορά, from μεταφέρω, *I transfer*). From the evidence furnished by many words Locke conjectured that, if all words could be traced back to their roots, 'we should find in all languages the names which stand for things that fall not under our senses to have had their first rise from sensible ideas.' [LANGUAGE.] The progress of philological science has proved not only that the conjecture of Locke is fully warranted by fact, but that what he with other philosophers regarded as a peculiarity of certain *words*, was really the peculiarity of a whole *period* in the history of human speech. During this period words had simply a material meaning; and men gave utterance to nothing beyond strictly sensuous impressions. This is clear on an examination of such words as *grace* and *immortality*; the former, now used to express the highest gifts of God to man, being traceable to a time when it expressed simply the brightness derived from fat or oil, and the latter to a time when it denoted anything which could not be pounded or ground. Hence 'no advance was possible in the intellectual life of man without metaphor;' but the metaphorical process was, according to Professor Max Müller, of two kinds, the radical and poetical. *Radical* metaphor is 'when a root which means to shine is applied to form the names not only of the fire or the sun, but of the spring of the year, the morning light, the brightness of thought, or the joyous outburst of hymns of praise.' In such cases, the word rises from the merely material or sensuous object to a mental conception which has a certain analogy with the sensuous object originally denoted by the word. *Poetical* metaphor is 'when a noun or verb, ready made and assigned to one definite object or action, is transferred poetically to another object or action. For instance, when the rays of the sun are called the hands or fingers of the sun, the nouns which mean hand or finger existed ready made, and were as such transferred poetically to the stretched-out rays of the sun. . . . What applies to nouns, applies likewise to verbs. A verb such as *to give birth* is used, for instance, of the night producing, or more correctly preceding the day, as well as of the day preceding the night. The sun under one name is said to beget the dawn, because the approach of daylight gives birth to the dawn, under another name the sun is said to love the dawn, because he follows her as a bridegroom follows his bride; and lastly the sun is said to destroy the dawn, because the dawn disappears as soon as the sun has risen.' The results of this process would be homonymy and polyonymy: by the first, objects originally quite distinct would receive the same name; the second would furnish a vast number of names to denote the same object. On these two conditions depends the growth of MYTHOLOGY, which is 'but a part of a much more general phase through which all language has at one time or other to pass.' (Max Müller, *Lectures on Language*, second series, viii.)

Metaphosphoric Acid. A term by which some chemists designate the protohydrated phosphoric acid $= HO, PO_5$. The salts of this acid are *monobasic*.

Metaphysics (Gr. μετά; φύσις, *nature*). A word employed, in popular usage, to denote enquiries relating to objects which are not merely physical and sensible. It is a remark of Sir James Mackintosh, that 'the term *metaphysics* affords a specimen of all the faults which the name of a science can combine. To those who know only their own language it must, at their entrance on the study, convey no meaning. It points their attention to nothing. If they examine the language in which its parts are significant, they will be misled into the pernicious error of believing that it seeks something more than the interpretation of nature. It is only by examining the history of ancient philosophy that the probable origin of this name will be

found, in the application of it as the running title of several essays of Aristotle, which were placed in a collection of the manuscripts of that great philosopher *after* his treatise on physics.' To which it may be added that the title of the works in question (τὰ μετὰ τὰ φυσικά) was not given, as far as is known, by Aristotle himself, but appears to have been first used by one of the later Peripatetics, possibly Andronicus Rhodius (B. C. 80).

Metaphysics, however, in the modern sense of the word, has been defined to be the science which regards the ultimate grounds of being, as distinguished from its phenomenal modifications. As a means of attaining this end, it considers the correlative of being, knowledge; and knowledge, not merely in reference to its *form*, as it is capable of law and regulation, for that is the province of logic—nor in regard to its history, and the successive stages of its developement, which are the objects of psychology, or mental philosophy—but knowledge as it is in relation to being, or objective reality. Philosophers have not been satisfied with marking the resemblances of the appearances in nature, and the order in which they succeed each other, whether those appearances were outward and sensible, or internal and revived by observation of their own mental processes; they have not even been content with the discovery that their knowledge of phenomena was self-consistent, and obeyed certain determined or determinable canons or forms; they have felt that the highest end of science could then only be attained when all knowledge was perceived to depend on a one ultimate principle, which should demonstrate at once its consistency with itself and its absolute foundation in reality. That the science of this ultimate unity is that to which the greatest philosophers have with more or less distinctness assigned the name of metaphysics, the history of philosophy sufficiently proves.

As it would be impossible, for the purposes of the present work, to attempt either an analysis or a history of this branch of scientific investigation, the present article will be confined to a brief summary and nomenclature of the principal writers and schools of modern metaphysics, or psychology.

1. The scholastic writers of the middle ages, proceeding on the road which they conceived Aristotle to have indicated, regarded metaphysics, or the science of the mind, as the highest branch of philosophy, and made it the special object of their close but narrow investigation. Two great sects arose among them: (1) that of the Realists, who maintained (according to the philosophy attributed to Plato) the real existence of universal ideas or universals; (2) the Nominalists, who denied it, and taught that these universals were names only, invented and used for purposes of classification. [LOGIC.] To the first class belonged Thomas Aquinas, and, in general, the chiefs of what was esteemed the more orthodox scholastic philosophy; to the second, Abelard, Ockham, and others of less celebrity. In the fifteenth century the disputes of the two sects produced violent quarrels, which were only put an end to by the more profound dissensions of the Reformation. Generally speaking, the innovators in religion adhered to the nominalist cause in philosophy (Luther, Melanchthon, &c.); but the original controversy died away, to revive under new shapes and designations in modern metaphysical enquiries.

2. Omitting the bold, but not systematic, efforts of Campanella and some other Italian philosophers at, or soon after, the period of the revival of letters, we may proceed to France as the country in which modern metaphysical science was first entered on in earnest. Descartes (1596–1650) stands at the head of the French school; deriving the reality of things from the phenomena of thought, and therefore occupying the position of leader of what has been called the spiritualist, in opposition to the materialist, school. Pascal (1625–1664) was an independent thinker, but approaching the principle of Cartesianism; of which the chief supporter in France, and to a certain extent the reformer, was Nicolas Mallebranche, whose *Recherche de la Vérité* appeared in 1674. But it was developed in a more remarkable manner by a thinker of a higher order, who belongs to France by his mental education, although by birth a Dutch Jew, Spinosa (1632–1677). After the decay of the great Cartesian school, no metaphysician, strictly so called, of any great distinction appeared in France, until the philosophy of Locke had penetrated the thinkers of the eighteenth century. Bonnet (1720-1795), the Encyclopedists (Dalembert and Diderot), Cabanis (1757–1807), and especially Condillac (1715–1780), reduced the science of mind, step by step, to complete materialism. In recent times, Victor Cousin, by his adaptation of Scotch and Kantist principles, and, still more, the great apostle of Positivism, Comte (although not directly a teacher of metaphysics), have, among many others, attempted in various ways to bring back the current of French opinion in the direction of spiritualism.

3. Omitting Leibnitz as a speculator of a more general class, John Christian Wolf (1679–1764) deserves the title of the founder of the German school of metaphysics. But its greatest name is that of Immanuel Kant (1724–1804). Rejecting, and powerfully combating, the hypothesis of Locke which deduced all knowledge from the senses, he endeavoured to establish in opposition to it that *philosophy of pure reason* (or *transcendental*) based on à priori grounds, which has since been carried so far by his admirers and followers in Germany and elsewhere. The greatest of these are the paradoxical Fichte (1762–1814), Schelling (1775–1854), and Hegel (1770–1831).

4. The history of metaphysical science in England can be nowhere studied in so concise and comprehensive a form as in Dugald Stewart's *First Preliminary Dissertation to the Encyclopædia Britannica.* Hobbes, Locke,

Bishop Berkeley, and Hume, are the four great thinkers of the early period who, in various ways, and by widely different yet cognate trains of reasoning, established what is commonly called the *materialistic theory*; and, in doing so, became the founders of the French encyclopedist school already mentioned, and also promoted that popular developement of thought and action which in recent times has changed the whole aspect of society. The Scottish or modern school: Reid (*Inquiry into the Human Mind*, 1764), Dugald Stewart himself, and Dr. Brown (*Lectures on the Philosophy of the Mind*) have been termed eclectic, as holding an intermediate place between the simple materialism of the former and the transcendentalism of the Germans. The last name to be mentioned in this rapid summary is that of Sir William Hamilton, whose system has been lately subjected to a rigid criticism by Mr. J. S. Mill. (*Examination of Sir William Hamilton's Philosophy.*)

Metaplasm (Gr. *μεταπλασμός*, from *πλάσσω*, *I form*). In Grammar, a general term, comprehending all those figures of diction which consist in alterations of the letters or syllables of a word; taking place in three ways —by augmentation, diminution, or immutation. 1. Augmentation at the beginning, *prosthesis*; in the middle, *epenthesis*; at the end, *paragoge*; to which may be added *diæresis*, adding to the number of syllables by the resolution of a diphthong. 2. Diminution at the beginning, *aphæresis*; in the middle, *syncope*; at the end, *apocope*; by contraction of two vowels, *synæresis*. 3. Immutation, *antithesis*, signifying the change of one letter for another; *metathesis*, transposition of the order of letters. [See those heads.]

Metapophysis (Gr. *μετά*; *ἀπόφυσις*, *a process*). In Anatomy, the exogenous process commonly situated between the diapophysis and anterior zygapophyses: in the human skeleton it is best developed in the last dorsal and first lumbar vertebræ; the metapophyses are developed more, and from more numerous vertebræ, in most of the inferior mammalia, arriving at their maximum of length in the armadillos, in which they equal the neural spines in length in the posterior dorsal and the lumbar vertebræ. They relate in these singular quadrupeds to the support of the carapace, the neural spines representing the *king-posts*, and the metapophyses the *tie beams*, in the architecture of a roof.

Metastasis (Gr. *change of position*). The transference or translation of a disease from one part of the body to another.

Metatarsus (Gr. *μετά*, and *ταρσός*, sc. *ποδός*, *heel*). The instep is so called by anatomists.

Metatartaric Acid. A modification of tartaric acid produced when the latter is heated to 340° Fahr. Its salts are more soluble than those of ordinary tartaric acid. [Tartaric Acid.]

Metathesis (Gr.). In Grammar, the transposition of the letters of a word, a process not unfrequently exhibited in the words of kindred languages, as in the German *ross*, English *horse*. [Metaplasm.]

Metaxite. A fibrous variety of Serpentine. The same name is given by Delesse to Chrysotile.

Metayer (Fr.; Lat. medietarius). A form of tenure peculiar to the south-western countries of Europe, in which the tenant pays a portion of the produce to the landlord, from whom he receives tools, stock, and seed. As the proportion paid was generally one-half of the produce, the name *metayer* was given to this kind of tenure, although the amount varies with the goodness of the soil and the quantity of stock supplied.

A kind of tenure closely analogous to métairie prevailed for a short time in this country during the latter part of the fourteenth and the beginning of the fifteenth centuries. Before this time, the lord almost invariably cultivated his estate by a bailiff, and the tenant farmer was practically unknown. After the great pestilence of 1348, the wages of labour increased so much, despite the various enactments made to check the rise, that it became generally no longer profitable to cultivate land by hired labour, and the estates were let in greater or smaller parcels to tenants on lease. As, however, the lords had stocks on hand, these stocks, with a certain amount of seed, were leased with the land to the tenant, the tenant covenanting to replace the stock at the expiry of his lease, or to pay a fixed sum in compensation for them. From obvious causes this temporary expedient in the history of English agriculture was soon abandoned, métairie was succeeded by farmers' rents, and finally by the yeomanry tenure of small proprietors; the wars of the Roses, and the gradual impoverishment of many among the ancient nobility, having contributed powerfully to the change, by breaking up the great, but generally scattered, estates of the chief proprietors.

Considerable difference of opinion has prevailed as to the economical effect of metayer tenancy. Arthur Young, who visited great part of France and Italy just before the French Revolution, speaks generally in disparaging terms of this form of tenure. On the other hand, Jones, Sismondi, and Mr. Mill have expressed themselves favourably of the results of this holding. In all probability, all are in the right. Before the era of the Revolution, the rights of the seigniors were far less defined, and their tenants were more liable to oppression. At present, however, it appears that the balance of advantage is on the side of the tenant, who holds in effect his lands in perpetuity, subject to the payment of a tax, analogous to a tithe, and like a tithe easily convertible into a money payment.

Mete-stick. On Shipboard, a measure used in stowing the cargo, in order to preserve proper levels.

Metempsychosis (Gr. *μετεμψύχωσις*). A Greek word denoting the migrations of the

soul through different successive bodies. The doctrine of the transmigration of souls has existed in the belief of various religious and philosophical sects from the remotest antiquity. It formed the leading doctrine of one of the most celebrated schools of philosophy in the whole heathen world [PYTHAGOREAN PHILOSOPHY]; it was said to have found many adherents in Egypt; but it is chiefly among the Indians that this doctrine has taken deep and permanent root. The Indian doctrine of *metempsychosis* rests on the supposition that all beings derive their origin from God, and are placed in this world in an altogether degraded condition, from which they all, but more particularly the human race, must either decline into still lower degradation, or rise gradually to a higher state, as they give ear to the vicious or the virtuous suggestions of their nature. It must be remarked, however, that the Indians make a wide distinction between the future destiny of those who have passed through life tainted by the usual vices and infirmities of human nature, and those whose lives have been spent in the constant discharge of religious duties. In the latter case, the soul does not pass through different stages of existence; 'but proceeds directly to reunion with the Supreme Being, with which it is identified, as a river at its confluence with the sea merges therein altogether. His vital faculties, and the elements of which his body consists, are absorbed completely and absolutely; both name and form cease; and he becomes immortal, without parts or members.' (Colebrooke's translation of extracts from the *Brama-Sutras*, in the *Transactions of the Royal Astronomical Society*, vol. ix.)

Metemptosis. [PROEMPTOSIS.]

Meteorolite. [AËROLITE.]

Meteorology (Gr. μετεωρολογία). The science of meteors, or the science which explains the various phenomena which have their origin in the atmosphere. Under the term *meteorology* it is now usual to include not merely the observation of the accidental phenomena to which the name of meteor is applied, but every terrestrial as well as atmospherical phenomenon, whether accidental or permanent, depending on the action of heat, light, electricity, and magnetism. In this extended signification, meteorology comprehends climatology, and part of physical geography; and its object is to determine the diversified and incessantly changing influences of the four great forms of natural force now named, on land, in the sea, and in the atmosphere. [See ATMOSPHERE; CLIMATE; and the various terms referred to under METEORS.]

Meteors (Gr. μετέωρα). A name given to any phenomena of a transitory nature which have their origin in the atmosphere. Meteors are of various kinds. Some are produced simply by a disturbance of the equilibrium of the atmospheric fluid, and are called *aërial meteors*. [WINDS; WHIRLWINDS.] A second class arise from the deposition of the aqueous particles which the atmosphere holds in a state of invisible vapour, and which are precipitated in consequence of a diminution of temperature, sometimes in a liquid and sometimes in a solid form. These are called *aqueous meteors*. [DEW; FOGS; HAIL; RAIN; SNOW; VAPOURS, &c.] A third class of meteors, or atmospherical phenomena, are caused either by the action of the precipitated aqueous particles dispersed in the atmosphere on the rays of light, or by the unequal heating of the air owing to which the rays of light are under certain circumstances reflected. [FATA MORGANA; HALO; MIRAGE; PARHELIA; RAINBOW.] A fourth class comprehends those which present the phenomena distinctive of combustion or incandescence. [AËROLITE; AURORA BOREALIS; FIRE BALLS; LIGHTNING; SHOOTING STARS, &c.]

Meteors, Luminous. The generic name now given to those phenomena which result from the entrance into and combustion in our atmosphere of bodies known as *falling* or *shooting* stars, *bolides*, *meteors*, *aërolites*, and *meteoric stones*.

Recent investigations have shown that these phenomena are to be classed no longer in the domain of meteorology, as was so long supposed, but in that of astronomy, as they result from the entrance into our atmosphere of small bodies revolving round the sun like our earth, with this difference, that they do not travel singly, but are congregated in several rings — tangible orbits, as it were. The falls of shooting stars are due to the passage of our planet through one of these rings; whereas the meteors which appear from time to time, termed *sporadic meteors*, are bodies which, according to M. Faye, have not accomplished the immediate down-rush into our atmosphere, but have for a time been satellites to our earth until at length its attraction has proved too powerful for them.

Much of the recent progress is due to the labours of Mr. Alexander Herschel in this country, and Mr. Newton in America. Their cosmical origin has been placed beyond all doubt by the fact, among other considerations, that the star-falls observed from the earliest times and recorded in the Chinese annals have always occurred at the same day or nearly so of the *tropical* year, i.e. they have always happened in the same part of the earth's orbit. The dates at which at the present epoch star showers are expected are August 10 and November 11. In 1799 and 1833 the meteors were so numerous that it has been estimated that 34,000 fell per hour. Much alarm was caused among uncivilised people in consequence. Mr. Newton has estimated that the average number of meteors which traverse the atmosphere daily is 7,500,000. The meteors observed on the same date are generally found to issue from one point in the sky, called the *radiant point*, and astronomers have therefore concluded that the appearances are due to several of the rings to which we have before referred. We have one

ring which furnishes the August meteors, and another the November meteors, and the position of these rings in space is very different, for while one lies nearly in the plane of the earth's orbit, the other is inclined to it at a considerable angle.

The heights of shooting stars at their entrance and extinction are on the average seventy-three and fifty-two miles, with a probable error of three miles only. Their velocity is generally thirty-five miles a second. The weight of some of them has been estimated: shooting stars have been observed weighing two ounces, large meteors weighing two hundredweight. Thus the motion of the smaller masses is soon converted into heat sufficient to raise them to a state of incandescence, and we see them as shooting or falling stars. The larger ones can resist this vapourising action longer, as they approach the surface of the earth, and we see them as glowing coloured meteors; while the largest masses resist the action longer still—they complete their fall, perhaps burst, and spread masses of meteoric iron over large areas. The composition of aërolites is very constant, and their study has given rise to the most interesting speculations.

Metheglin (Ger. meth, *mead*). A beverage made of honey and water, fermented by the addition of yeast.

Methionic Acid (Gr. μετά, and θεῖον, *sulphur*). An acid obtained by the action of anhydrous sulphuric acid on ether; althionic acid is at the same time formed.

Method. This word, from the Greek μέθοδος, which signifies a journey undertaken in quest of any object, or a way of attaining any end, denotes any mode of investigating truth. Thus we have the dialectic method, the inductive method, the analytical method, &c. [DIALECTICS; INDUCTION; ANALYSIS.]

Methodic Medicine. Medicine as practised by the methodic sect of physicians, of which Themison was the head. They endeavoured to reduce medicine to exact rules, and assumed that all diseases arose from constricted fibre.

Methodists. The body of Christians to whom this name is chiefly applied are the followers of John Wesley, the founder of this sect: hence called Wesleyan Methodists. But the term bears a more extensive meaning, being applied also to several bodies or sections of Christians who have seceded or withdrawn from the Wesleyan denomination.

The origin of the Methodist society took place at Oxford in 1729. After the Revolution, when the principles of religious toleration were recognised, the clergy of the Established Church were thought by some to have sunk into a state of lukewarmness and indifference. This alleged degeneracy was observed with pain by John Wesley and his brother Charles, while students at Oxford; and being joined by a few of their fellow-students, they formed rigid and severe rules for the regulation of their time and studies, for reading the Scriptures, for self-examination, and other religious exercises. This observance of system in everything connected with the new opinions, as well as in their college studies, gained for them the appellation of *Methodists*; in allusion to the *methodici*, a class of physicians at Rome who practised only by theory. (Celsus, *De Medicina*.)

In the mean time Wesley took orders in the Established Church, and acted for a few months as assistant to his father, who was rector of Epworth, in Lincolnshire. After the death of the latter he was induced (1735), in company with his brother Charles and two other friends, to accept an offer to go to Georgia, in North America, to preach the Gospel to the Indians. On his return to England in 1737, Wesley officiated in several churches of the Establishment. But the higher ranks were offended at his declamatory mode of preaching; and the churches in general were soon shut against him. It was his desire to be allowed to officiate in the pulpit of his native church. But the circumstances to which we have referred threw his labours into a different, and ultimately an opposite, channel; and in short, without having at first intended it, he became the founder of the most numerous class of Dissenters in Great Britain.

Being thus virtually expelled from the Established Church, he preached in Dissenting chapels in London and other places where he could obtain admission. In course of time, and owing to the vast multitudes that crowded to listen to his ministrations, he adopted the expedient of preaching in the open air. He first formed his followers into a separate society in 1738, the year after his return from America, though he referred the establishment of Methodism to a prior date. Wesley, from this date, devoted his time and talents exclusively to the propagation of what he regarded the doctrines of the Gospel. His labours were chiefly confined to England; but he also paid visits to Scotland and Ireland, in the former of which his success was inconsiderable. But while he confined his own labours to Great Britain and Ireland, he was not inattentive to the spiritual necessities of other countries, and, by means of a succession of missionaries, propagated his doctrines in America and many of the West Indian islands.

The success which attended his missionary exertions was not gained without obloquy, particularly in the United Kingdom. Owing to the liberality of the age, neither himself nor any of his missionaries were exposed to stripes and imprisonment; but all of them met with great opposition, and some of them were beset with mobs, and sometimes dragged through the streets as raving enthusiasts and disturbers of the public peace.

Finding his societies rapidly increasing, and having been refused assistance from the Established clergy, Wesley was induced to have

recourse to lay preachers; an expedient which he was at first exceedingly averse to adopt, but which he afterwards found most efficient in promoting the triumph of his views. He was thus enabled to exercise superintendence over all his followers, and greatly to extend his sphere of action.

Wesley denied the doctrine of election, though he admitted that *certain* persons and churches have been elected, and that *great* events have been foreordained; and differed from the system of Calvin in regard to the extent of the Atonement, which he maintained was for all men; and held that repentance preceded faith. (In addition to Wesley's works, particularly his *Sermons*, see Benson's *Apology for the Methodists*; and Myles's *Chronological History of the Methodists*.) Wesley and his followers continued long after their separation from the Established Church to read the service of that church; nay, the practice was continued, in a few instances, after his death.

The Methodists have adopted a system of discipline and government which seems to partake as much of presbytery as of any other polity. Of this system, which is very complicated, the following are the leading features: Each society or congregation is divided into smaller bodies, called *classes*, each class embracing from twelve to twenty persons, one of whom is styled the *leader*. Each society has also a body of men called *stewards*, whose office is similar to that of deacon in the Established Church. The duties of leaders—namely, visiting the sick and holding religious intercourse with the members belonging to their class—are, in many respects, akin to those of lay-elders in the Presbyterian Church of Scotland. The leaders, stewards, and minister meet once a week (and this is called a *leaders' meeting*), on the religious business of the society; and to account for the funds received from the members.

A number of these societies united constitutes a *circuit*, while one of the ministers within the district is termed the *superintendent*. The ministers officiating in the circuit meet all the classes quarterly, and speak personally to each member. Those whose conduct is devoid of reproach receive a ticket, the chief use of which is to prevent imposture. After the conference with the classes another meeting (called a *quarterly meeting*) is held, consisting of all the ministers, leaders, and stewards in the circuit. On this occasion the stewards deliver their collections to a *circuit steward*; and everything relating to secular matters is publicly settled. At this meeting, also, the candidates for the ministry are proposed; and the stewards, after a definite period of service, are changed.

From five to ten or fifteen of the circuits, according to their extent, form a *district*, the ministers in which meet annually; the meeting being termed a *district meeting*. This assembly has authority 'to try and suspend ministers who are found immoral, erroneous in doctrine, or deficient in ability; to decide concerning the building of chapels; to examine the demands from the circuits respecting the support of clergymen; and to elect a representative to attend and form a committee, four days before the meeting of the annual conference, in order to prepare a draught of the stations for the ensuing year. The circuit stewards are present at this meeting during the settlement of all financial matters. The judgment of the assembly is conclusive until the meeting of the conference, to which an appeal is allowed in all cases.

The *conference*, which is the supreme judicatory, and whose decisions are final, consists, strictly speaking, only of a hundred of the senior itinerant preachers, in terms of a deed of declaration executed by Wesley and enrolled in chancery. In this deed the meeting is termed 'the Conference of the people called Methodists.' But the conference is generally composed of the preachers elected at the previous district meetings to be their representatives, of the superintendents of the circuits, and of every minister who chooses to attend; all of them being allowed the same right of voting as the hundred, or legal conference. From this body all authority emanates; and by them all regulations to be observed throughout the whole Methodist connection are framed. They appoint ministers to their respective stations. The results of their discussions are annually published after each meeting, under the title of *Minutes of Conference*, which embody the laws of the society. (*General Rules of the Methodist Society*; Adam's *Religious World*, vol. iii. pp. 113-119.)

At the death of Wesley, in 1791, there were, in Great Britain and Ireland, about 300 itinerant preachers in connection with the new sect, and 1,000 local preachers—some of them, however, having very small congregations—and 80,000 members. But the Wesleyan Methodists have established foreign stations in Australia, Van Diemen's Land, &c.; and so rapidly have they increased, that the number of Wesleyan Methodists in 1850, both at home and abroad, amounted to upwards of two milions; and the total number of preachers, regular and supernumerary, was 6,000.

Various offshoots have taken place from the Wesleyan Methodists at various times; among the most important of which may be reckoned the followers of Whitfield, once the coadjutor, and afterwards the most powerful and eloquent opponent of Wesley, and supporter of Calvinism; the Methodists of Lady Huntingdon's connection, in whose chapels service is performed according to the ritual of the church of England; the Welsh Calvinistic Methodists; the Primitive Methodists [RANTERS]; the New Connexion Methodists; the Independent Methodists [INDEPENDENTS], &c. Some of these sects, particularly the Whitfieldians, are nearly allied in government and discipline to the Independents. (In addition

to the works already quoted, see *Journal of John Wesley*; *Lives of Wesley*, by Coke, Moore, and Southey; Nightingale's *Portraiture of Methodism.*)

The total number of places of worship belonging to the Methodists of every class, and to *isolated congregations* of similar tenets, in England and Wales, amounted in 1851 to about 12,600. (*Census.*)

Methyl. The hydrocarbon radical of methylic alcohol. It is a colourless inflammable gas burning with a luminous flame, and is obtained from its iodide by the action of zinc at a high temperature under pressure, as also by the electrolysis of acetate of potash. Its *hydride* is MARSH GAS. Its *oxide* or *methylic ether* is gaseous at ordinary temperatures, but like its homologue, vinic or ethylic ether, it forms definite compounds with acids. The *hydrated oxide of methyl*, *methylic alcohol*, *wood spirit*, or *pyroxylic spirit*, is one of the products of the destructive distillation of wood: after rectification it is sent into commerce in a very impure state under the name of *wood-naphtha*.

Methylamine. Ammonia in which one atom of hydrogen is replaced by methyl. It is an inflammable gas greatly resembling ammonia in its chemical character. It may be formed by the action of iodide of methyl upon ammonia, and subsequent distillation with potash.

Methylated Spirit. Alcohol mixed with one-tenth of its volume of wood spirit. By this admixture its solvent powers are not deteriorated, and it may be used in the manufacture of varnishes, and for many other applications in the arts, while the disagreeable flavour communicated by the wood spirit prevents its being employed as a substitute for gin, or other intoxicating liquors. The excise regulations permit the sale of this article free of duty, which is a great boon to many of the arts and manufactures.

Methylene. A hydrocarbon composed of two atoms of carbon and two of hydrogen ($C_2 H_2$).

Metis (Gr.). One of the small planets belonging to the group between Mars and Jupiter. [ASTEROID.]

Metœci (Gr. μέτοικοι, *sojourners*). The resident aliens, who formed a large class of the inhabitants of Athens. They were distinguished from the few full citizens by many disabilities and burdens. They had no share in the administration of the state, and were precluded from the power of possessing landed estates. Each was compelled to purchase the protection which he received from the state by the payment of a small annual sum (μετοίκιον), and to place himself under the guardianship of a citizen (προστάτης), who was his formal representative in the courts of law. They were generally engaged in mercantile and mechanical business.

Metonic Cycle (so called from Meton, its inventor, B.C. 432). A cycle of nineteen years, or, more accurately, of 6,940 days; at the end of which time the new moons fall on the same days of the year, and the eclipses return in nearly the same order. The reason of this is, that in nineteen solar years there are 235 lunations (with a difference of a few hours), and very nearly one complete revolution of the moon's nodes. The cycle was corrected by Calippus. [CALIPPIC PERIOD; CYCLE.]

Metonymy (Gr. μετωνυμία, *change of name*). In Rhetoric and Composition, a figure by which the name of an idea or thing is substituted for that of another, to which it has a certain relation. Thus, the effect is frequently substituted for the cause—*grey hairs* stands for *old age*: the abstract for the concrete—'What doth gravity' (i.e. the grave person) 'out of his bed at midnight?'—substance for quality, precedent for subsequent, &c.

Metope (Gr. μετόπη). In Architecture, the square space in the frieze between the triglyphs in the Doric order. It is either left plain or decorated, according to the taste of the architect. In the most ancient examples of this order, the metopes were left quite open. [ARCHITECTURE.]

Metopion (Gr.). An ancient ointment containing galbanum, which was formerly called *Metopium.*

Metoposcopy (Gr. μέτωπον, *a forehead*, and σκοπέω, *I view*). The art of divination by inspecting the forehead, treated of especially by the famous Cardanus. The signs of the forehead are chiefly its lines; but moles and spots are also supposed to have their particular meaning. The lines are under the dominion of their several planets.

Metre (Gr. μέτρον, *measure*). In the classical sense of the word, a subdivision of a verse. The Greeks measured some species of verses (the dactylic, choriambic, antispastic, Ionic, &c.) by considering each foot as a metre; in others (the iambic, trochaic, and anapæstic) each *dipodia*, or two feet, formed a metre. Thus, the dactylic hexameter (the heroic verse) contained six dactyls or spondees: the iambic, anapæstic, and trochaic *trimeter*, six of those feet respectively. A line is said to be *acatalectic* when the last syllable of the last foot is wanting; *brachycatalectic*, when two syllables are cut off in the same way; *hypercatalectic*, when there is one superfluous syllable. [FOOT, in Prosody.]

MÈTRE. The French unit of length. [MEASURES.] It is somewhat longer than an English yard, being, in fact, equal to 39·37079 English inches. By an Act of Parliament passed in 1864, the mètre was rendered a legally valid measure throughout Great Britain and Ireland.

Metric System. A system of weights and measures adopted first in France, and now slowly superseding the systems in use in other countries.

The two most important points of this system are: firstly, that it is a *decimal system*, and secondly, that the units of length, superficies,

solidity, and weight, are all correlated, two data only being used, the *mètre* and the weight of a cube of water the side of which is the $\frac{1}{100}$th part of a mètre.

The system was suggested as long ago as 1528 by Jean Fernal, a physician of Henry II. of France; but the suggestion took a practical turn in 1790, when Prince Talleyrand distributed among the members of the Constituent Assembly of France a proposal, founded upon the excessive diversity and confusion of the weights and measures then prevailing all over that country as now over our own, for the foundation of a new system upon the principle of a single and universal standard. (*Report on Weights and Measures* by John Quincy Adams, p. 49, Washington 1821.)

A committee of the Academy of Sciences, consisting of five of the most eminent mathematicians of Europe — Borda, Lagrange, Laplace, Monge, and Condorcet—were subsequently appointed, under a decree of the Constituent Assembly, to report upon the selection of a natural standard; and the committee proposed in their report that the ten-millionth part of the quarter of the meridian of Paris should be taken as the standard unit of lineal measure.

Delambre and Méchain were appointed to measure an arc of the meridian between Dunkirk and Barcelona, as Cassini had been appointed in 1669. They commenced their labours at the most agitated period of the French Revolution. At every station of their progress in the field-survey they were arrested by the suspicions and alarms of the people, who took them for spies or engineers of the invading enemies of France. The result was a wonderful approximation to the true length, and one in the highest degree 'creditable to the French astronomers and geometricians, who carried on their operations, under every difficulty, and at the hazard of their lives, in the midst of the greatest political convulsion of modern times.' (*Essay on the Yard, the Pendulum, and the Mètre*, by Sir John F. W. Herschel, p. 19, London 1863.)

By means of the arc of the meridian measured between Dunkirk and Barcelona, and of the arc measured in Peru, in 1736, by Bouguer and La Condamine, the length of the quarter of the meridian, or the distance from the pole to the equator, was calculated. This length was partitioned into ten millions of equal parts, and one of these parts was taken for the unit of length, and called a mètre, from the Greek word *μέτρον* (*a measure*). (Briot's *Arithmetic*, translated by J. Spear, p. 152: Hardwicke, London 1863.)

If the arc of the meridian be calculated from the result of French researches, the mètre itself is equal, in English measurement, to 39·37079 inches; and, multiplying this length by ten million, the length of the quadrant of the meridian, when converted into feet, will be 32,808,992 feet. Sir John Herschel estimates the length of the quadrant of the meridian at 32,813,000 feet; so that, according to his calculation, there is a difference between the French and the new estimate of the quadrant of 4,008 feet, and therefore the French length of the quadrant is $\frac{1}{8182}$th too short and the mètre is $\frac{1}{208}$th of an inch less than the length of the ten-millionth part of the quadrant.

This error of $\frac{1}{208}$th of an inch in the determination of the mètre, however, supposing it possible to establish it absolutely, does not make the metric system less complete or convenient; it is more than counterbalanced by the extreme simplicity, symmetry, and convenience of the system. Professor Bessel observed with respect to the mètre, that, in the measurement of a length between two points on the surface of the earth, *there is no advantage at all* in proving the relation of the measured distance to a quadrant of the meridian. (*Report of a Committee of the House of Commons on Weights and Measures*, p. 109, 1862.) Professor Miller of Cambridge, who quotes this remark, deems the error in the relation of the mètre to the quadrant of the meridian to be of no consequence; and he mentions another slight error in the metric system, discovered by recent research, relating to the density of water, which he gives in the following words of Bessel (from the *Populäre Vorlesungen*, by Professor Bessel, published in 1848, soon after his death):—

'The kilogramme (1,000 grammes) is not exactly the weight of a cubic decimètre of water. Many of the late weighings show that water at its maximum density has a different density from that which was assumed by the French philosophers who prepared the original standard of the kilogramme; but nobody wishes to alter the value of the gramme on that account.'

Two important principles form the basis of the metric system: 1. That the unit of linear measure, applied to matter, in its three forms of extension—viz. length, breadth, and thickness—should be the standard of all measures of length, surface, and solidity. 2. That the cubic contents of the linear measure, in distilled water, at a temperature of great contraction, should furnish at once the standard weight and measure of capacity.

Thus: 1. The *unit of length* was the *mètre*, as we have seen, the 10,000,000th part of a quadrant of the earth's surface.

From this we derive: 2. The *unit of superficies*—the *are*, a square décamètre. 3. The *unit of capacity*—the *litre*, a cubic décimètre. 4. The *unit of weight*—the gramme, the weight of a cubic décimètre of water.

The following tables, compiled by Mr. Warren de la Rue, will show the beautiful simplicity of this system—a simplicity arising from the decimal system, the correlation of the different units, and the uniform nomenclature adopted for the subdivisions and multiples of the units.

METRIC SYSTEM

Comparison of French and English Measures.

Length.

	In English Inches	In English Feet = 12 Inches	In English Yards = 3 Feet	In English Fathoms = 6 Feet	In English Miles = 1,760 Yards
Millimètre	0·03937	0·0032809	0·0010936	0·0005468	0·0000006
Centimètre . . .	0·39371	0·0328090	0·0109363	0·0054682	0·0000062
Décimètre	3·93708	0·3280899	0·1093633	0·0546816	0·0000621
Mètre.	39·37079	3·2808992	1·0936331	0·5468165	0·0006214
Décamètre	393·70790	32·8089920	10·9363310	5·4681655	0·0062138
Hectomètre . . .	3937·07900	328·0899200	109·3633100	54·6816550	0·0621382
Kilomètre	39370·79000	3280·8992000	1093·6331000	546·8165500	0·6213824
Myriomètre . . .	393707·90000	32808·9920000	10936·3310000	5468·1655000	6·2138244

1 Inch = 2·539954 Centimètres.
1 Foot = 3·0479449 Décimètres.

1 Yard = 0·91438348 Mètre.
1 Mile = 1·6093149 Kilomètre.

Surface.

	In English Square Feet	In English Square Yards = 9 Square Feet	In English Poles = 272·25 square Feet	In English Roods = 10,190 Sq. Feet	In English Acres = 43,560 Sq. Feet
Centiare or square mètre .	10·7642993	1·1960333	0·0395383	0·000988457	0·0002471143
Are, or 100 square mètres.	1076·4299342	119·6033260	3·9538290	0·098845724	0·0247114310
Hectare, or 10,000 square mètres	107642·9934183	11960·3326020	395·3828959	9·884572398	2·4711430996

1 Square Inch = 6·4513669 Square Centimètres.
1 Square Foot = 9·2899683 Square Décimètres.

1 Square Yard = 0·83609715 Square Mètre or Centiare.
1 Acre . . = 0·404671021 Hectare.

Capacity.

	In Cubic Inches	In Cubic Feet = 1·728 Cubic Inches	In Pints = 34·65923 Cubic Inches	In Gallons = 8 Pints = 277·27384 Cubic Inches	In Bushels = 8 Glls. = 2218·19075 Cubic Inches
Millilitre, or cubic centimètre .	0·061027	0·0000353	0·001761	0·00022010	0·000027512
Centilitre, or 10 cubic centimètres	0·610271	0·0003532	0·017608	0·00220097	0·000275121
Décilitre, or 100 cubic centimètres	6·102705	0·0035317	0·176077	0·02200967	0·002751208
Litre, or cubic décimètre . .	61·027052	0·0353166	1·760773	0·22009668	0·027512085
Décalitre, or centistère . . .	610·270515	0·3531658	17·607734	2·20096677	0·275120846
Hectolitre, or décistère . . .	6102·705152	3·5316581	176·077341	22·00966797	2·751208459
Kilolitre, or stère, or cubic mètre.	61027·051519	35·3165807	1760·773414	220·09667675	27·512084594
Myriolitre, or décastère . . .	610270·515194	353·1658074	17607·734140	2200·96676750	275·120845937

1 Cubic Inch = 16·3861759 Cubic Centimètres.
1 Cubic Foot = 28·3153119 Cubic Décimètres.
1 Gallon = 4·543457969 Litres.

Weight.

	In English Grains	In Troy Ozs. = 480 Grains	In Avd. Lbs. = 7,000 Grains	In Cwts. = 112 Lbs. = 784,000 Grains	Tons = 20 Cwts. = 1680,030 Grains
Milligramme	0·015432	0·000032	0·0000022	0·00000002	0·000000001
Centigramme	0·154323	0·000322	0·0000220	0·00010020	0·000000010
Décigramme	1·543235	0·003215	0·0002205	0·00000197	0·000000098
Gramme	15·432349	0·032151	0·0022046	0·00001968	6·000000984
Décagramme	154·323488	0·321507	0·0220462	0·00019684	0·000009842
Hectogramme	1543·234880	3·215073	0·2204621	0·00190841	0·000098421
Kilogramme	15432·348800	32·150727	2·2046213	0·01968412	0·000984206
Myriogramme	154323·488000	321·507267	22·0462126	0·19684118	0·009842059

1 Grain = 0·064798950 Gramme.
1 Pound Avoirdupois = 0·45359265 Kilogramme.

1 Troy Ounce = 31·103496 Grammes.
1 Cwt. = 50·80237689 Kilogrammes.

Such is the system which after much opposition was finally introduced into France by King Louis Philippe, and which sooner or later must probably become universal. In England it is already extensively used by scientific men, and in 1864 an Act was passed legalising its use in this country. The Act, however, is merely a permissive one.

The metric system of weights and measures has been adopted, not only by France, but in Italy (except the portion under pontifical government), Spain, Portugal, Greece, Belgium, and Holland; it has been partially received in Denmark and Switzerland, which adopts the half-kilogramme as the pound. The majority of the states composing the *Zollverein*, or Customs League, in Germany, have expressed their approval of the metric system. The half-kilogramme has been introduced into all great mercantile operations in Austria.

At the International Statistical Congress, held at Berlin in September 1863, thirty-three nations of Europe and America were represented by statistical delegates, and the congress agreed to the following fundamental resolution on weights and measures: 'The adoption of the same measure in international commerce is of the highest importance. The metric system appears to the congress to be the most convenient of all the measures

that could be recommended for international measures.'

A commission of the Imperial Academy of Sciences in St. Petersburg has recommended that such alterations should be made in Russian weights and measures as would put them in conformity with the metric system of France. Dr. Kupffer, a delegate from the Russian government, has declared that Russia would recommend the adoption of the pure metric system if Great Britain would take the lead. 'We wish England,' said Dr. Kupffer, 'to take the lead. England is a country of prior civilisation. Let England do it, and we are sure to follow.'

In the United States of America a committee has been appointed by congress to consider the subject of metric weights and measures; and the system has been adopted in Mexico, Chili, Peru, New Granada, Ecuador (to commence in 1866), Bolivia, Venezuela, and French and Dutch Guiana. For more information on this system, Mr. Dowling's Tables (Lockwood & Co.) should be consulted: the prefaces contain much valuable information.

Metronome. In Music, an instrument invented by Maelzel, and used to measure time, and to indicate the velocity with which a composition ought to be played. It has a small pendulum, which, being set in motion by clockwork, beats, audibly, a certain number of times in a minute; and this number may be altered by moving a sliding weight, and adjusted to varying degrees of quickness or slowness as required. It is now customary to mark, at the beginning of a piece of music, the number of beats per minute intended by the composer; thus 𝅗𝅥 60 means that when the metronome is adjusted to 60 it will beat the time of minims for that piece, giving 60 minims in a minute.

Metropolis (Gr. *the mother city*). 1. A parent state from which colonies have sprung; in which sense the word is uniformly employed by ancient Greek writers. 2. The chief city of a province in the later ages of the Roman empire. The Christian church having adopted the secular division of the Roman empire into provinces, the episcopal seat established in every such city, and the bishop of it himself, were termed metropolitan. In modern usage, the word is applied to denote the chief or capital city of an independent state.

Metropolitan. In Ecclesiastical History, a title applied to the prelate who presides over the other bishops in a province. The establishment of metropolitans took place at the end of the third century, and was confirmed by the council of Nice.

Metrosideros (Gr. μήτρα, *the heart of a tree*, and σίδηρος, *iron*). Of this extensive Myrtaceous genus, one or two New Zealand species are remarkable for their hard close-grained timber. That of the Rata, *M. robusta*, is used for shipbuilding, and by the natives for making war clubs, paddles, &c.; that of the Kawa, *M. tomentosa*, called Firetree by the colonists on account of the brilliancy of its flowers, is used for similar purposes; and that of the Aka, *M. scandens*, is called New Zealand Lignum Vitæ, on account of its hardness.

Mexican Gulf. A remarkable expanse of nearly enclosed ocean, which occupies, with the Caribbean Sea and the West Indian Islands, an area of more than two millions of square miles, shut in by the two Americas to the north and south, by Central America to the west, and almost enclosed by the long range of the Antilles towards the Atlantic. Its waters, which vary in depth from 500 to 1,000 fathoms, are very warm; and from it issues a remarkably warm, rapid, and important marine current, whose exact cause and origin cannot easily be traced.

The gulf of Mexico is the northernmost and innermost portion of this great sea. Enclosed on the north and west from the southern extremity of the peninsula of Florida to the extremity of the remarkable peninsula of Yucatan, and partly shut in by the western extremity of Cuba, it is reached by only two narrow openings, one communicating with the Caribbean Sea and the other with the Atlantic. The Bahama banks almost prevent access in the latter direction.

Although this gulf lies between 20° and 30° north of the equator, the oceanic warmth equator not only passes through it, but there attains its maximum temperature, the heat of the water being there estimated at 88½°, although it is not more than 80° at the equator, off the coast of Africa, near the hottest parts of that continent, and nowhere across the Atlantic rises above 84°. The hottest water of the Atlantic is, therefore, always in this sea—a fact which greatly influences the climate of America, and ultimately that of England. [GULF STREAM.]

Mezereon (Pers. Madzaryoun). The common name of the *Daphne Mezereum.*

Mezzanine (Ital. mezzano, *middle*). In Architecture, a story of small height introduced between two higher ones.

Mezzo Rilievo (Ital.). A term applied in Sculpture to the decoration executed in a middle style of relief, i.e. distinct from either the basso rilievo or the alto rilievo. The figures on the shaft of the Trajan's column, or on the column of the Place Vendôme, are examples of this style of sculpture. [RELIEF.]

Mezzo Soprano (Ital.). In Music, a low soprano.

Mezzotinto (Ital. half-tinted). A method of engraving on copper in which a burr is raised all over the plate, and subsequently scraped away in the parts that are intended to be left light. The modern engravers usually etch their plates before raising this kind of burr, which enables them to execute the work more rapidly, but less picturesquely, than in the old style.

This method of mezzotinto engraving was invented by Ludwig von Siegen in 1642. [ENGRAVING.]

Mi. The French and Italian name for the note corresponding to our E.

Miargyrite. A sulphide of antimony and silver found at Braünsdorf in Saxony.

Miasma (Gr. from μιαίνω, *I infect*). Infectious or contagious matter. The term is generally applied, under the name of *marsh miasma* (malaria of the Italians), to the infectious emanations from marshy lands and stagnant waters, which are peculiarly characterised by producing various forms of intermittent and remittent fevers. [MALARIA.]

Mica (Lat.). A term under which are comprised several varieties of a mineral generally found in thin *elastic* laminæ, with a glistening lustre, and of various colours and degrees of transparency. It is one of the constituents of granite.

The micas have been divided into three groups: viz. Muscovite, Phlogopite, and Biotite. The *Muscovites*, which are confined to granite and other igneous rocks, are biaxial, and generally contain potash or lithia, and a small quantity of magnesia. The *Phlogopites* are also biaxial, though in a less degree than the Muscovites: they are found only in granular limestone and serpentine, and contain magnesia, and often only a small quantity of alkali. *Biotite* or Magnesia Mica is uniaxial, and contains large quantities of oxide of iron, magnesia, and potash.

The Micas are chiefly composed of silica, alumina, magnesia, potash, lithia, and some other bases.

In some parts of Siberia and elsewhere, Mica forms an article of trade, often known under the name of *Muscovy glass*.

Mica Slate or **Mica Schist.** A very abundant metamorphic rock—slaty, and essentially composed of mica and quartz. Mica sometimes forms the whole mass. Garnets are sometimes embedded as crystals in it, and form an integral part of the rock, which is then called *garnet schist*. Argillaceous matter is occasionally mixed with the mass, which thus assumes a slaty appearance.

Mica slate, abounding in garnets, and often sprinkled with red patches produced by decomposition, and becoming syenitic from the interspersion of hornblende, is prevalent upon the banks of the Tay and about Dunkeld in Scotland; but it is in Glen Tilt that the geologist, both practical and theoretical, will find the most ample materials for the study of the association and junctions of this series of rocks.

In the immediate neighbourhood of Blair, the Tilt exhibits upon its banks a section of the rocks forming its bed; and the micaceous strata here and at the falls of the Bruar incline nearly at the same angle to several points of the compass, giving a curious confusion and interweavement to their assemblage.

The group of schistose rocks containing mica is large, and widely distributed wherever metamorphic rocks are found. Such rocks may belong to any geological period, but they have been formed at a great depth beneath the surface, and under enormous pressure. They are most usual in mountain districts, but abound also in all places where an axis of elevation has brought up granite or porphyritic rock. The western extremity of all the British Islands, the western coast of France, and of the Iberian peninsula, and the flanks of the principal mountain chains, are the chief localities of these rocks in Europe. [GNEISS.]

Micaceous Iron-ore. The name given to those kinds of Hæmatite or Red Iron-ore which possess a micaceous structure.

Micado. [TYCOON.]

Michael, St., Order of. A French order of knighthood, instituted by Louis XI. in 1469, in honour of St. Michael, the supposed ancient protector of France. It was for some time after its institution in high repute; but under Catherine of Medicis, who lavished it indiscriminately, it came to be held of no account.

Michaelite. A white, fibrous, and pearly variety of Opal found in the island of St. Michael, in the Azores.

Michaelmas. The feast of St. Michael the Archangel. It falls on the 29th of September, and is supposed to have been established towards the close of the fifth century; Brady says in 487. In England, Michaelmas is one of the regular periods for settling rents.

Michelia (after Pietro Antonio Micheli, a Florentine botanist of the eighteenth century). A genus of *Magnoliaceæ*, consisting of large trees belonging to India and the Eastern Archipelago, distinguished from *Magnolia* by its axillary flowers, and other peculiarities. *M. Champaca*, the Chumpaka of the Hindus, and sacred to Vishnu, is commonly cultivated in India for the powerful fragrance of its flowers. The root is bitter, and used medicinally.

Microcline (Gr. μικρός, *small*, and κλίνω, *to incline*). A green and blue variety of Felspar, containing nearly equal quantities of potash and soda.

Microcosm (Gr. μικρόκοσμος, *a little world*). Man has been called so by some fanciful writers on natural philosophy and metaphysics, by reason of a supposed correspondence between the different parts and qualities of his nature and those of the universe.

Microcosmic Salt. The ammonio-phosphate of soda; it is obtained among the products of the evaporation of urine, and was formerly used as a blowpipe flux.

Microdactylus (Gr. μικρός, and δάκτυλος, *a digit*). A name proposed by M. Geoffroy for the short-toed genus of wading birds called by Illiger DICHOLOPHUS [which see].

Microdon (Gr. μικρός, and ὀδούς, *a tooth*). The name of a genus of extinct fishes, belonging to the thick-toothed or Pycnodont family, in the Ichthyological system of Agassiz.

Microlestes (Gr. μικρός, and λῃστής, *thief*). A genus of marsupial mammalia, found in the upper triassic bone bed at Stuttgardt, in Wurtemburg, and near Aust, in Gloucestershire. The minute crescent-shaped teeth of this animal exhibit the nearest affinity to those of the fossil *Plagiaulax* of the Purbeck strata, which was a small carnivorous marsupial, allied to

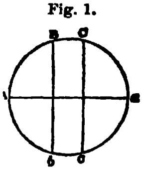
Thylacolea. As far as present knowledge affords data, the *microlestes* is the earliest representative of the mammalian class in this planet.

Microlite (Gr. *μικρός*, *small*, and *λίθος*, *stone*). A name for the columbate of lime found at Chesterfield in Massachusetts.

Micrometer (Gr. *μικρός*, and *μέτρον*, *measure*). An instrument applied to telescopes and microscopes for measuring very small distances, or the diameters of objects which subtend very small angles. A great number of contrivances of various kinds, and depending on different principles, have been employed for this purpose; but it will be sufficient to give a general description of some of the most useful or remarkable ones.

Wire Micrometer.—This instrument, when placed in the tube of a telescope, at the focus of the object-glass, presents the appearance represented in the annexed figure (fig. 1). A *a* is a spider's web line, or very fine wire fixed to the diaphragm; and B *b* and C *c* are similar wires stretched across two forks, each connected with a milled-head screw. By means of these screws the two wires, B *b* and C *c*, which are exactly parallel to each other, are movable in the direction perpendicular to A *a*; and, in order that the wire A *a* may be placed in any direction relatively to the meridian, there is an adjusting screw, which works into an interior toothed wheel, and turns the apparatus round in its own plane perpendicular to the axis of the telescope.

Fig. 1.



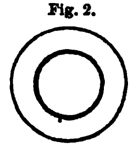
The method of using the micrometer is as follows: Suppose the object to be accomplished to be the measurement of the *angle of position* and distance of two very close stars; the telescope being set and kept on the objects, the micrometer is turned by its adjusting screw until the spider line A *a* coincides with the line joining the two stars, or *threads* them both at the same moment. The milled heads of the screws, which carry the two movable wires, are then turned until B *b* bisects one of the two stars, and C *c* bisects the other. The observation is now completed, and it only remains to ascertain the position and distance indicated by the micrometer. For the first of these purposes, the circumference of the micrometer is divided into degrees and minutes, and read by two verniers: this reading gives the position of A *a* in respect of the horizontal and vertical planes, and consequently the angle of position of the two stars. To find their distance, the head of the screw which carries one of the movable wires, for instance C *c*, is turned until C *c* coincides with B *b*; and the number of revolutions, and parts of a revolution required to effect the coincidence, gives the distance of the stars when the value of the *scale* of the micrometer is known: that is to say, when the number of seconds of space which correspond to one revolution of the screw is known. The screws must be made with great accuracy, and their heads are usually divided into sixty equal parts, representing seconds.

The value of the scale, or of a revolution of the screw, is obtained in the following manner: Set the two wires, B *b* and C *c*, apart to a certain number of revolutions, and place them in the direction of the meridian. Observe the transits of several stars of known declination over the wires; then multiply each interval of seconds by 15, and by the cosine of the star's declination; and, taking the mean, you have the seconds of space which correspond to a known number of revolutions of the screw. (See Appendix, by the Rev. R. Sheepshanks, to Professor de Morgan's *Explanation of the Gnomonic Projection of the Sphere.*)

Circular Micrometer.—This instrument, which differs entirely from the above, was first suggested by Boscovich, in the *Leipzic Acts* for 1740, and used by Lacaille in observing a comet in 1742; but seems afterwards to have fallen into disuse, until it was revived by Dr. Olbers, about 1798. The principle may be explained as follows: If the field of a telescope be perfectly circular (which may be effected by means of a diaphragm turned in a lathe), and if its diameter be determined from observation, the paths of two celestial bodies across the field may be considered as two parallel chords, which are given in terms of a circle of known diameter. The differences of the times at which two stars arrive at the middle of their paths will be their ascensional differences; and the distance between the chords, which is readily computed from their lengths, gives the difference of the declinations of the two bodies.

The most approved construction of the annular micrometer is that of Fraunhofer. It consists of a disc of parallel plate glass (fig. 2), having in its centre a round hole of about half an inch in diameter, to the edges of which a ring of steel is cemented and afterwards truly turned in a lathe. The disc being mounted in a brass tube, so that it may be accurately adjusted in the focus of the eye-piece, and applied to a telescope, the steel ring is alone visible, and appears as if suspended in the atmosphere, whence the instrument is called the *suspended annular micrometer*. The advantage of this construction consists in the accuracy with which the moment of ingress or egress is determined, from the body being seen in the field of view before it comes up to the edge of the steel ring. The annular micrometer is conveniently used for comparing the place of a small star or a comet with that of a known star in nearly the same parallel of declination. (*Astronomische Nachrichten*, b. iv.)

Fig. 2.

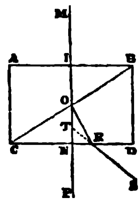


Divided Object-glass or Double Image Micrometer.—This instrument is formed by dividing the object-glass of a telescope or microscope into two halves, the straight edges

being ground smooth, so that they may easily slide by one another. A double image of an object in the field of view is produced by the separation of the segments; and, by bringing the opposite edges of the two images into contact, a measure of the diameter of the object is obtained in terms of the extent of the separation. From its being used to measure the diameter of the sun, this is usually called the *heliometer*. [HELIOMETER.] Instead of a divided object-glass, Ramsden preferred a divided lens in the eye-tube, which form of the instrument is called the *dioptric micrometer*. The double image micrometer was suggested by Roemer, about 1678; but first brought into use by Bouguer, about 1748.

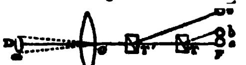
Micrometer by Double Refraction.—The Abbé Rochon conceived the ingenious idea of applying the principle of double refraction to micrometrical measurement. Conceive two prisms, A B C and B C D (fig. 3), formed of the same crystal, and so disposed that the face A B of the first is perpendicular to the axis of the crystal, while, in the second, the axis is parallel to the line of the intersection of the two faces C B and C D, so that the axes of crystallisation of the two prisms are at right angles to each other. The prisms are placed in perfect contact, and cemented by mastic; and together form a plate of which the opposite sides are parallel. Now, suppose a ray of light M I to fall perpendicularly on the face A B; it will proceed through the prism A C B, in the same straight line I O, without being separated, because I O is parallel to the axis of the crystal. But when it arrives at O, and enters the second prism B C D, it will be separated into two: the ordinary ray will continue to follow the same direction I O N P, because the refracting powers of the two prisms are the same; but the extraordinary ray will take a different direction O R (towards B D, if the crystal is attractive, as rock crystal; but towards A C, if the crystal is repulsive, as Iceland spar), and, on emerging from the prism at R, will be refracted in the line R S. The angle P T S of the inclination of the two rays after their emergence from the prism is constant for the same crystal, and must be determined by experiment.

Fig. 3.



Let us now conceive this apparatus to be placed in the tube of a telescope, of which O (fig. 4) is the object-glass and F the focus, and the telescope directed upon a distant object at D (as a planet), the diameter of which, *m n*, is to be measured. Suppose the double prism at T′: two images will be formed; the ordinary image at *a*, and the extraordinary image at *b′*. By sliding the prisms along the tube towards O, the distance between the images will be increased; by sliding them towards the focus F, it will be diminished; and if placed exactly in the focus, the two images will coincide. Let V denote the visual angle or apparent magnitude of the object, *f* the focal distance F O of the telescope, U the constant angle *a* T *b* depending on the prism, and D the distance F T: we shall then have the diameter of the image $= f \tan V$, and the distance $a\,b = D \tan U$. Now, if the apparatus be slid along the tube from T′ to T, where the two images are in contact, then the diameter of the image will be equal to the distance *a b*; and we have, consequently, $f \tan V = D \tan U$. Here the quantities *f* and U are found by experiment; whence V, the angular magnitude of the object, becomes known in terms of D.

Fig. 4.



The prism micrometer, when constructed in the manner now described, has this important defect, that the extraordinary image is accompanied by the prismatic colours, especially if the angle to be measured exceeds a few minutes; and hence Rochon found that he could not use it for measuring the diameters of the sun and moon. But this defect has been ingeniously remedied by M. Arago, by simply altering the arrangement of the apparatus, and giving the double prism a fixed position out of the tube and before the eye-glass. By this disposition two images are formed at the focus, the centres of which are fixed points, whose distance depends on the refracting power of the crystal; and the contact of the images is produced by increasing or diminishing the magnifying power of the eye-glass, instead of altering the position of the prism. The magnifying power thus becomes the measure of the visual angle subtended by the diameter of the observed object.

Various modifications of the three principles now explained have been proposed; for details respecting which we refer to Brewster's *Treatise on New Philosophical Instruments*; to the article 'Micrometer,' in the ***Encyclopædia Britannica***, by the same author; and to Dr. Pearson's *Introduction to Practical Astronomy*. Other plans will be found described in Herschel's *Outlines of Astronomy*.

The micrometer is an instrument of the utmost importance in astronomy, and one, in fact, to which that science is as much indebted as to the telescope itself. From a paper by Mr. Townley, in the *Philosophical Transactions* for 1667, it appears certain that a micrometer with a movable wire was first constructed by our countryman Gascoigne about the year 1640, and used by him for measuring the diameters of the moon and some of the planets; but as Gascoigne, who was killed in the civil wars in 1644, published no account of his invention, the instrument was entirely forgotten, and the merit of reinventing it, and bri[illegible] it into general use, belongs to the F[illegible] astronomer Azout, who published a description of it in 1667. Huygens, a few years previously, had contrived to measure the diameter of a

planet by inserting in the tube of a telescope, at the focus of the object-glass and eye-glass, a slip of metal which covered exactly the image of the planet, and then deducing the diameter from the breadth of the slip, compared with the diameter of the field; and Malvasia had employed for the same purpose a reticle or network of fine silver wires, crossing each other at right angles, and dividing the field of the telescope into a number of equal squares. (For the history of the invention and successive improvements of the micrometer, see the notes by Mathieu to Delambre's *Histoire de l'Astronomie au 18me Siècle*, pp. 616 and 645.)

Micrometer for the Microscope, and Methods of Measuring.—The microscope micrometer may be made upon the same principles as the telescope micrometer. The instruments in use among microscopists are *Jackson's micrometer* and the *cobweb micrometer*. The first consists of a small glass plate, upon which lines are drawn equidistant from one another. This is inserted in the eye-piece, and so arranged that it may be moved across the field of vision by the aid of a screw. The value of each division being ascertained by placing objects of known dimensions, or lines drawn at known distances apart, in the field, the object to be measured is carefully placed against the first division, and the position accurately adjusted by the screw. The number of divisions to the width of the object may then be carefully read off.

The cobweb micrometer was invented by Ramsden, and the principle of its action is precisely the same as that of the wire micrometer. By turning the screw which approximates or separates the frames across which the cobweb threads are stretched, the slightest alteration of the lines can be estimated, and a difference even of $\frac{1}{100000}$ of an inch rendered appreciable.

Practically, however, there is some difficulty in obtaining measurements of very minute objects, by the use of micrometers of any kind, adapted to the eye-piece; for unless the body of the microscope be very firm, in which case it will be inconveniently heavy, it is almost impossible to adjust the micrometer without a slight disturbance of the body, and this slight movement may cause a measurement very wide of the truth; especially when the highest powers are used, for the value of each division of the micrometer becomes altered according to the power of the object-glass employed, and in the case of the high powers this value becomes enormously increased, and of course any error in the determination is increased in a corresponding degree.

In practice, the following will be found the most successful method of measuring objects in the microscope. It was first proposed by Mr. Lister. The stage micrometer referred to is simply a slip of glass, upon which lines have been ruled at the distance of $\frac{1}{10000}$, $\frac{1}{5000}$, $\frac{1}{2000}$ or $\frac{1}{1000}$ of an inch apart. These stage micrometers are to be obtained of the opticians. The lines are scratched by a diamond point, attached to a beautiful instrument, by which lines can be drawn at any distances apart with the greatest precision. M. Nobert has succeeded in drawing these lines so close to one another, that more than 100,000 would go in the space of a single inch; and the beautiful mechanism used for drawing these lines is so true, and the lines so clear, that they may be used as test objects for ascertaining the defining power of object-glasses.

In Mr. Lister's method of measuring, a camera lucida, or a neutral tint glass reflector, or a steel disc placed at an angle of 45°, must be adapted to the eye-piece, and the microscope placed horizontally, as in the position for drawing objects with the aid of the above instruments. In the field of the microscope is placed an ordinary stage micrometer, with the lines separated by thousandths of an inch, care being taken that the instrument is arranged at about ten inches from the paper; the lines, magnified by a quarter-inch object-glass, are carefully traced with a sharp-pointed pencil; the micrometer is then removed, and replaced by the object whose diameter is to be ascertained. The object is traced over the lines or upon another piece of paper, and compared with the scale by the aid of compasses. The lines may be engraved upon a slate, and their value affixed, so that any object may be at once measured. Of course a different scale is required for each power. Such scales may be made upon pieces of gummed paper, and one of them should be affixed to every microscopical drawing. In comparing the representation of the same object delineated by different observers, it will often be found that great confusion has arisen in consequence of the magnifying power of the object-glass not having been accurately ascertained; and an object stated by two different authorities to be magnified the same number of times, is nevertheless represented much larger by one than by the other. This discrepancy in most cases arises from the magnifying power of the glasses not having been accurately ascertained in the first instance. For further information on measuring objects in the microscope, the reader is referred to the works of Quekett, Carpenter, or Beale.

Microphone (Gr. μικρός, and φωνή, *a voice*). An instrument for increasing the intensity of low sounds, by communicating their vibrations to a more sonorous body, the sounds emitted by which are thus rendered more audible.

Micropyle (Gr. μικρός, and πύλη, *a gate*). In Botany, a perforation through the skin of a seed, over against the apex of the nucleus.

The hard envelopes of the ova of insects (Meissner) and many other animals also exhibit one or more openings or micropyles, through which the spermatozoa pass, and thus obtain access to the ovum. The micropyle is usually a funnel-shaped opening, exhibiting a great variety of markings in different species. (Allen Thompson's article 'Ovum' in Todd's *Cyclopædia of Anatomy and Physiology*, Supplement, p. 111.)

Microscope (Gr. μικρός, and σκοπέω, *I view*). An optical instrument which enables us to see and examine objects which are too minute to be seen by the naked eye. Microscopes are single or compound, according to the nature of their construction; a single microscope being one through which, whether it consists of a single lens or a combination of lenses, the object is viewed directly; while a compound microscope is one in which two or more lenses are so arranged that an enlarged image of the object formed by one of them is magnified by the second, or by the others, if there are more than two, and seen as if it were the object itself.

Single or Simple Microscope.—This instrument is, for the most part, simply a lens or sphere of any transparent substance, which refracts the rays of light issuing from a small body placed in its focus, and gives them such a degree of convergency as is necessary for distinct vision. In order that the rays of light issuing from the several points of a very small body may produce a sensible impression on the retina of the eye, it is necessary that the object be brought very near the eye; but when this is done, the rays coming from its different points are so divergent as to produce only a confused image. Now, if a convex lens be interposed between the object and the eye, and so placed that its distance from the object may be a little less than its focal distance, the diverging rays issuing from the object are refracted by the lens, and enter the eye placed behind it, either parallel, or so nearly parallel as to afford distinct vision. The object is then seen in the direction of the refracted rays, and at the distance at which it could be distinctly seen by the naked eye; and consequently magnified in the ratio of the distance of distinct vision to the focal distance of the lens. This ratio is called the *magnifying power* of the lens; hence, for single microscopes, the magnifying power is equal to the distance at which a small object can be seen distinctly by the naked eye, divided by the focal distance of the lens; and, as the distance of distinct vision is constant (at least for the same individual), the magnifying power is inversely as the focal distance. If we suppose the distance which limits distinct vision, in respect of minute objects, to be five inches (which is about the average for good eyes), and the focal distance of the lens to be one inch, the object will be magnified five times in linear dimensions, and twenty-five times in superficial. If the focal distance is one-tenth of an inch, the magnifying power will be fifty in linear extent, and 2,500 in superficial.

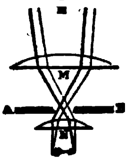
A single microscope may be obtained very easily by piercing a small circular hole in a slip of metal, and introducing into it a drop of water, which will assume a spherical form on each side of the metal. Or a small piece of glass may be placed upon a small circle of fine platinum wire, from which a piece projects as a sort of handle, and melted in the flame of a spirit lamp, when a minute bead will be obtained; some of these are so uniform as to make excellent simple lenses. The substance commonly used for microscopic lenses is plate glass; but they are sometimes formed of rock crystal, which is better. Flint glass, by reason of its great dispersive power, is unfitted for the purpose. The precious stones, as the garnet, ruby, sapphire, and diamond, have been proposed; but the numerous and skilful attempts of Mr. Varley and Mr. Pritchard have proved that the advantages arising from the greater refractive power of those substances are more than counterbalanced by their colour, reflective power, double refraction, and heterogeneous structure. The crystalline lenses of minnows and other small fishes give a very perfect image of minute objects.

When the object to be examined is of such magnitude as to subtend an angle of some degrees, the requisite distinctness cannot be given to its whole surface by an ordinary lens, in consequence of the confusion occasioned by the lateral rays; unless, indeed, the rays are only permitted to enter the lens through a very small aperture, whereby the quantity of light is greatly diminished. In order to remedy this inconvenience, Dr. Wollaston contrived a form of lens, to which he gave the name of *periscopic lens*. Its construction is as follows: two plano-convex lenses or hemispheres are ground to the same radius, and between their plane surfaces a thin plate of metal, with a circular aperture, is introduced. The aperture which appeared to give the most distinct image was about one-fifth of the focal length in diameter; and, when the aperture well centred, the visible field was as much as 20° in diameter. A lens of this kind possesses the double advantage of having a very short focal distance, and very little spherical aberration. Dr. Wollaston's contrivance may, however, be improved upon in various ways; for example, by filling up the central aperture with a cement of the same refractive power as the lenses, whereby the loss of light from the double number of surfaces is avoided; or by grinding away the equatorial parts of a sphere of glass, so as to leave a deep groove all round it, in the plane of a great circle perpendicular to the axis of vision, and filling the groove with opaque matter. This last construction is called the *Coddington lens* (from the name of its proposer); and when executed in garnet, and used in homogeneous light, it is considered by Sir David Brewster to be the most perfect of all lenses, either for single microscopes, or the object-lenses of compound ones.

In using a single lens as a magnifier, it is always necessary that the light be made to pass through a very small aperture, in order that the object may be seen distinctly and without distortion. This necessity arises both from the spherical aberration and the chromatic dispersion of the light falling on the surface of the lens under an angle of considerable obliquity; and the consequence is that the c[illegible] of light admitted to the eye is so mu

nished that the object cannot be clearly seen. To remedy this inconvenience, Dr. Wollaston proposed a combination of two lenses, called, in consequence, *a microscopic doublet*, the optical part of which may be described as follows:

Fig. 1.

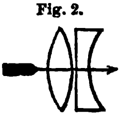


M and N (fig. 1) are two plano-convex lenses, whose focal lengths are in the ratio of 3 to 1, or nearly so, and placed one over the other, so that their plane sides are towards the object. The adjustment of the distance between the lenses is best accomplished by trial; and they must, accordingly, be mounted so that the distance can be varied at pleasure. A B is a diaphragm or stop for limiting the aperture. Though it does not appear that the stop was contemplated by Dr. Wollaston, who makes no mention of it, the performance of the microscope depends much on its nice adjustment. It is obvious that as each of the pencils of light from the extremities of the object is rendered eccentric by the stop, and made to pass through the two lenses on opposite sides of the common axis, they are affected by opposite errors, which, in some degree, serve to counteract each other. This doublet, when correctly made, is infinitely superior to any single lens, and will transmit a pencil of from 35° to 50° without any very sensible errors. The original description, by Dr. Wollaston, is given in the *Phil. Trans.* for 1829.

The above construction has been improved upon by substituting two plano-convex lenses for N in the doublet, the plane side of the one being in contact with the convex side of the other, and the stop being retained between them and the third. This combination is called a *triplet*; and its advantage is, that the errors of the doublet are still further reduced by the greater approximation to the object, in consequence of which the refractions take place nearer the axis.

Another form of doublet, proposed by Sir John Herschel, is represented in the annexed figure (2).

Fig. 2.

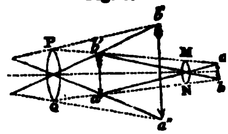


It consists of a double convex lens, whose radii of curvature are as 1 to 6; and of a plano-concave, whose focal length is to that of the other as 13 to 5, placed in contact with the flatter surface of the former, and having its concavity turned towards the object. Many other combinations have been proposed, but those which have now been described appear to be the most useful.

When the magnifying power of the lens is considerable, and consequently its focal distance very small, it requires to be placed at the proper distance from the object with great precision; and, as it cannot be held in the hand with sufficient steadiness for any length of time, it requires to be mounted in a frame having a rack and screw, by means of which its distance from the object can be adjusted with accuracy. Mirrors for collecting the light and throwing it upon the object are also necessary for many purposes.

Compound Microscope.—The simplest kind of compound microscope is formed by the combination of two converging lenses, whose axes are placed in the same straight line. The arrangement of the lenses, and the path of the rays, will be readily understood from the annexed diagram (fig. 3).

Fig. 3.



M N is the object-glass, which has a very short focal distance, and P Q the eye-glass. A small object $a\,b$ being placed before the object-glass, a little farther from it than the focus of parallel rays, a reversed and enlarged image $a'\,b'$ will be formed at some distance behind M N. The lens P Q is placed at such a distance from M N that its principal focus is in the line at $a'\,b'$; consequently the rays of light from every point of the image $a'\,b'$ emerge nearly parallel from P Q, and to the eye at E the image $a'\,b'$ is magnified, as if it were a real object, into $a''\,b''$, and appears at a distance equal to the limits of distinct vision, which, as stated above, is about five inches.

The magnifying power of this microscope, or the ratio of $a''\,b''$ to $a\,b$, is found as follows: In the first place, if we assume d to denote the distance of the first image $a'\,b'$ from M N, and f the distance of $a\,b$ from M N, or the focal distance of M N, we have this proportion, $a'b' : ab :: d : f$. In the second place, if l denote the limit of distinct vision, or distance of the second image $a''\,b''$ from P Q, and f' the focal distance of P Q (or distance of $a'\,b'$ from P Q), we shall also have $a''\,b'' : a'\,b' :: l : f'$. These two proportions, being multiplied together, give

$$\frac{a''\,b''}{a\ \ b} = \frac{d \cdot l}{f \cdot f'};$$

which, therefore, is the magnifying power of the microscope. It thus appears that the magnifying power is inversely as the product of the focal distances of the two lenses, and directly as the distance between them. The magnifying power will therefore be increased by increasing the distance between the object-glass and eye-glass; but a limit is soon placed to this increase by the indistinctness of the image, and, in practice, it is not advisable to make the distance of $a'\,b'$ from M N more than from five to ten inches. Some of the best modern object-glasses, however, bear a tube of very great length without much loss of definition. The object-glass may be separated from the eye-piece by twenty inches or more. Suppose the focal distance of M N to be $\frac{1}{4}$th of an inch, and the distance of $a'\,b'$ from M N to be five inches, then $a'\,b'$ will be twenty times greater than $a\,b$; and if the focal distance of P Q be half an inch, and the distance of $a''\,b''$ from P Q be five inches, then $a''\,b''$ will be

ten times greater than $a' b'$, and, consequently, 200 times greater than $a b$; or the magnifying power is 200.

The great defects of the microscope, when constructed in the manner now described, consist in the smallness of the field of view, and want of achromatism in the object-glass, in consequence of which the images $a' b'$ and $a'' b''$ are fringed with the prismatic colours. For the sake of enlarging the field of view, a third lens, larger than either of the others, and called the field-glass, is usually interposed between the image $a' b'$ and the object-glass.

Of late years the compound microscope has been very much improved, and is now a most valuable form of instrument. It consists essentially of a tube about ten inches in length, at the upper end of which is placed the *eye-piece*, while to the lower the *object-glass* is fitted. The *negative eye-piece* invented by Huygens for telescopes is the only one in use for the microscope, and is composed of two plano-convex lenses arranged as in the figure. By this eye-piece the *image* produced by the object-glass, brought to a focus in the tube of the microscope, is remagnified and corrected before it reaches the eye of the observer.

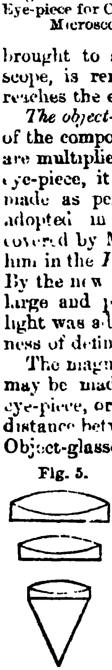
Fig. 4.

Negative or Huygenian Eye-piece for Compound Microscope.

The object-glass is the most important portion of the compound microscope; and as its errors are multiplied by the magnifying power of the eye-piece, it is most important it should be made as perfect as possible. The principles adopted in making object-glasses were discovered by Mr Lister and fully described by him in the *Philosophical Transactions* for 1830. By the new process he was enabled to obtain a large and perfectly flat field, by which more light was admitted without sacrificing distinctness of definition.

The magnifying power of the object-glasses may be made to vary by altering that of the eye-piece, or by increasing or diminishing the distance between the eye-piece and object-glass. Object-glasses are spoken of according to their focal length, as *the inch, quarter, eighth, twelfth,* &c.; but the glasses of the same reputed focus of different makers vary much in magnifying power. The *inch* with the low eye-piece should magnify about forty diameters, the quarter about 200, and so on. The best achromatic object-glasses consist of three lenses, each of which is composed of a bi-convex and a plano-concave lens, made of glass of different degrees of refracting power. The arrangement is represented in the figure. Mr. Wenham makes the third or lowest glass single, and finds that upon this plan excellent definition is obtained in glasses of very high magnifying power ($\frac{1}{25}$), while the operation of making the lens is much simplified.

Fig. 5.



Arrangement of Lenses in Achromatic Object-glass.

During the last few years lenses of very high power have been produced. In 1840 Messrs. Powell and Lealand succeeded in making a $\frac{1}{16}$th, magnifying about 1,000 diameters; in 1860, a $\frac{1}{25}$th, magnifying more than 1,500 diameters; and in October 1864, a $\frac{1}{50}$th, magnifying between 2,000 and 3,000 diameters. Mr. Wenham, however, completed a $\frac{1}{25}$th, which defined excellently, as early as June 1856. These very high powers are all excellent working glasses, and by their use important facts have been discovered. The difficulty of manipulation, preparing specimens, and covering them with thin glass, &c., is of course much increased, and no one should attempt to employ these very high powers until he is quite familiar with the use of lower ones.

Form of the Compound Microscope.—The forms of the compound microscope now in use are very numerous. Almost every maker modifies the general shape of the instrument and the arrangement of the adjusting apparatus in some particular. It is, therefore, impossible to describe the instruments even of the principal London makers, but it may be practically useful if the most important requisites of a good instrument are briefly enumerated. With reference to the optical part, the *inch object-glass* should magnify not less than thirty diameters, and the *quarter* not less than 200, when the lowest or *shallow eye-piece* is applied. The field should be well lighted, and the lines of delicate objects submitted to examination should be sharp and well defined; without coloured fringes when placed in the centre or at the circumference of the field. The mirror should be large (at least two inches in diameter), one side plane, the other concave; and it should be adapted to the body of the microscope in such a manner, that the distance from the object may be increased or diminished, while it is also necessary that it should possess lateral movement, in order that very oblique rays of light may be made to impinge upon the object.

With regard to the mechanical portion of the microscope, the adjustments should work smoothly, and an object placed in the field for examination should not appear to move or vibrate when the screws are turned. The body should be provided with a joint, so that it may be inclined or placed quite horizontally. The stage should be at least *three inches in length by two and a half in width*, and there should be a distance of at least an inch and a half from the centre of the opening in the stage, over which the slide is placed, to the upright body. The motion of the slide upon the stage, and all other movements and adjustments, should be smooth and even, without any tendency to a jerking or irregular action. (Beale's *How to work with the Microscope*, 3rd edition.) For cheap microscopes, perhaps the best mode of adjustment is that introduced by Mr. Ladd,

who employs a chain movement instead of the rack and pinion usually adopted.

The only other form of compound microscope which calls for notice here, is the hand or pocket microscope, which consists merely of the tube of the instrument with the eye-piece and object-glass. To the lower extremity of the telescope tube is attached a very simple form of stage, permitting the specimen to be examined in every part. The necessary focussing is performed by a screwing movement of the tubes which slide one within the other. The instrument is used like a telescope, and is most useful for field work. This microscope can be packed in a small case with all the necessary pipettes, glass slides, thin glass, &c. required for instituting microscopical examinations. It can be made very cheaply, and is particularly adapted for general use in schools.

Necessary Apparatus.—Every microscope should be furnished with certain pieces of apparatus; in the larger microscopes many elaborate instruments are usually added, which, not being absolutely necessary for all work, are not enumerated here. The essential things are as follows: *A neutral tint glass reflector for drawing and measuring objects*; a *diaphragm*, to the under part of which is fitted a tube to receive an *achromatic condenser* or *polarising apparatus*; a *bull's-eye condenser*; one *shallow eye-piece* and two object-glasses, *a low one magnifying from twenty to forty diameters*, and a *quarter of an inch which magnifies at least* 180 *diameters*; *a stage micrometer*, *a Maltwood's finder*, and an *animalcule cage* should also be supplied.

These instruments should be conveniently packed in the case with the microscope. The polarising apparatus and the achromatic condenser are not absolutely necessary for a beginner, and can be purchased afterwards. The cost of a student's microscope without these last instruments, but including the other apparatus mentioned, in a well-made case, should not be more than six pounds; and if the microscope be mounted upon a cast-iron foot, instead of a brass one, it may be obtained for about a pound less, without its practical utility being in any way impaired.

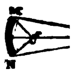
Of examining and preparing Microscopical Specimens.—This is one of the most important matters connected with microscopical enquiry, for the appearances of an object vary greatly according to the manner in which it is illuminated and the refractive power of the medium in which it is immersed.

If peculiarities in the surface of an object only are to be examined, the light may be thrown down upon it by the aid of an ordinary condensing lens, or perhaps the ordinary diffused daylight or lamplight may be sufficient. An object looked at in this way is said to be examined by *reflected light*. Objects examined by reflected light may be opaque or transparent; but if we desire to ascertain the internal arrangement of a texture, the object is so arranged that light may pass through it. The direct rays of a lamp or ordinary daylight may be employed, or if a stronger light be required, it may be obtained by bringing the rays to a focus upon the object by the aid of a concave mirror, or by a lens or system of lenses, as in the various forms of condensers fitted on to the microscope beneath the stage.

With regard to the media in which microscopic objects may be examined. The object may be mounted dry, being surrounded by air alone, or it may be immersed in water, serum, the fresh vitreous humour from the eye of an ox or sheep, or in media which refract the light more highly, such as syrup or glycerine, oil, turpentine, or Canada balsam. Glycerine and syrup have the advantage over the latter fluids, because, being miscible with water in all proportions, moist specimens may be immersed at once, and after time has been allowed for them to become fully saturated, they are ready for examination. All fruits and vegetables preserved in syrup will furnish the student with beautiful microscopic specimens. Objects to be mounted in turpentine, oil, or balsam must be dried first, or if moist subjected to a long and somewhat difficult process, by which the water is first expelled, and its place at last taken by the highly refracting fluid. Hard dry objects, such as hair, horn, nails, shells, bone, the hard coriaceous coverings of insects, and the dry parts of vegetables, may be mounted in these highly refracting fluids. Dr. Beale has recently introduced a new and uniform method of preparation adapted to objects of every kind. The preservative medium which he usually employs is the strongest glycerine made by Price and Company. (*How to work with the Microscope.*)

Reflecting Microscope.—The principle of the reflecting microscope is very simple, and easily conceived. Suppose M N (fig. 6) to be a concave speculum, and a small object to be placed before it at *f*. A reflected image of the object will be formed at F, where the rays issuing from each point of the object intersect each other, and magnified in the proportion of F M to *f* M. If the image at F is viewed with the naked eye, the instrument is a single reflecting microscope; but if the image is viewed through a refracting lens P Q (or a combination of lenses forming an eye-piece), by which the rays are made to converge towards the eye at E, it becomes a compound reflecting microscope.

Fig. 6.

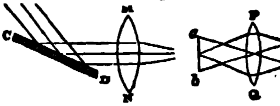


The reflecting microscope was first proposed by Sir Isaac Newton in the form now described; but, on account of the impracticability of illuminating the object, it was long disused. It has, however, been recently revived, under a modified form, by Professor Amici of Modena, who places the object outside the tube of the microscope, below the line N F; and, in order that an image may be formed in the speculum, the rays issuing from the object fall upon a small

plane mirror placed at *f*, inclined to the axis of the speculum in an angle of 45°, whereby they are thrown upon the speculum in the same manner as if the object itself were placed at *f*. By this means the object can be illuminated with perfect facility. The concave speculum M N is ground into an ellipsoidal surface; the diagonal mirror is placed at the nearest focus *f*, and the image is consequently formed at the other focus F. The image at F is viewed with a single or double eye-piece, as in other microscopes.

Solar and Oxyhydrogen Microscopes.—The solar microscope is composed essentially of a mirror and two converging lenses. The plane metallic mirror, C D (fig. 7), reflects the sun's rays upon the lens M N, by which they are

Fig. 7.



concentrated upon the object *a b* placed in its focus. The object, being thus strongly illuminated, is placed before a second lens P Q (a little before the principal focus), by which the rays are rendered still more convergent, and produce a magnified image of the object upon a screen suitably placed at a distance of some feet behind the lens. The object is here supposed to be transparent; if opaque, the light must be thrown upon it in such a manner as to be reflected by it to P Q. The mirror and lens M N are placed in the hole of a window shutter in a darkened room; and the mirror must be movable, in order that the sun's rays may always fall upon it under a proper angle to be reflected to the lenses. But the solar microscope is now almost entirely superseded by the *oxyhydrogen microscope*; so called because the illumination, instead of being produced by the sun's rays, is produced by burning a small piece of lime or marble in a stream of oxyhydrogen gas. In this case the plane mirror C D becomes unnecessary; and instead of the lens M N a concave speculum is employed, in front of which the ball of lime is placed, and an intense light thus thrown upon the object *a b*, the rays from which are brought to foci upon the screen by the lens P Q. For full details respecting the management of this apparatus, which forms a very popular exhibition, the reader is referred to Goring and Pritchard's *Micrographia*. Very perfect oxyhydrogen lanterns with achromatic lenses are now made, which are exceedingly valuable for class teaching. Photographs may be taken of the most delicate objects, and the negatives thus obtained remagnified in this instrument with the best results. In this way the structure of the most beautiful and minute objects may be rendered evident to a large number of people. Mr. How, of Foster Lane, and Mr. Highley, of Green Street, Leicester Square, have brought this plan of illustration to great perfection.

For descriptions of the various kinds of microscopes, see Brewster's *Treatise on New Philosophical Instruments*; *Encyclopædia Britannica*, art. 'Microscope;' Todd's *Cyclopædia*, art. 'Microscope;' *Micrographic Dictionary*; Quekett *On the Microscope*; Carpenter, *The Microscope and its Revelations*; Beale, *How to work with the Microscope*, and *The Microscope in Medicine*.

Middle Ages. A term usually employed to denote, somewhat vaguely, a space of several centuries in European annals, intervening between what are called the ancient and modern periods of history. The centuries between the ninth or tenth and the end of the fifteenth after Christ are generally comprehended under this loose denomination. In his work on the *Middle Ages*, Hallam has assumed as his period of commencement the conquest of Gaul by the Franks, about A.D. 500; and, for his conclusion, the invasion of Italy by Charles VIII., about 1500. With reference to the affairs of the Greeks and their Oriental neighbours, he places, as the most convenient limit between ancient and modern history, the era of Mohammed.

Middle Eocene. The subdivisions of the middle Eocene in the English series are altogether different from those met with in France, where the deposits are richest in fossils and most characteristic. The following subdivision will enable the reader to understand this. The details will be found under various headings.

London and Hampshire Basins	*Paris Basin*	
	Sables Moyens	Freshwater
Barton clays	Calcaire grossier and glauconie grossière	Upper flags
Bracklesham sands		Freestone
Lower Bagshot sands		Greenish
	Lits coquilliers and glauconie	

It is chiefly if not entirely the middle and lower part of the great Eocene series that contains the Nummulitic Formations, spread over a large part of the western world; and perhaps the most distinct and important of any beds of the Tertiary Period [which see]. The Claiborne beds of the state of Alabama in North America are also the equivalents of our Bracklesham beds, and contain many interesting fossils. Part of the basin of the Danube, with the lignite of Hungary and beds of true coal, occupy a similar position, although the Vienna basin is, in fact, of the middle tertiary or miocene period. Much of the brown coal of other parts of Germany belongs to this or the immediately overlying division of the tertiaries. [Eocene.]

Middle Latitude Sailing. In Navigation, a method of converting the departure (or distance on the parallel) into difference of longitude, and the difference of longitude into departure, when the ship's course is oblique to

the meridian. It is founded on this principle, which, however, is only approximately true in any case, and not even approximately in high latitudes, when there is also considerable difference between the latitudes left and arrived at; namely, that the departure may be accounted an arc of a parallel of latitude midway between the two extreme latitudes. Hence this rule:—

$$\cos \text{mid. lat.} = \frac{\text{departure}}{\text{diff. long.}}$$

(Jeans' *Navigation*, part ii.)

Middle Rail. In Architecture, the rail of a door level with the hand, on which the lock is generally fixed.

Middle Term of a Categorical Syllogism. In Logic, that term with which the two extremes of the conclusion are separately compared. [SYLLOGISM.]

Middletonite. A fossil resin found at the Middleton collieries near Leeds.

Midshipman. In the Navy, the step next above naval cadet. At nineteen years of age, if he have served five years, the midshipman passes an examination in seamanship, and another in navigation, when he becomes eligible for a lieutenant's commission, although he usually has to serve for some time as sub-lieutenant before obtaining it.

Midships. The middle of the ship, with reference to length or breadth. It is more commonly written *amidships*.

Miemite. A variety of Rhomb Spar of a green colour, from Miemo, in Tuscany.

Miesite. A brown variety of Pyromorphite, from Mies in Bohemia.

Mignonette (Fr.). A favourite garden flower, belonging to the same family as the Weld, and known in science under the name of *Reseda odorata.*

Migration (Lat. migratio). This word is used in Zoology to signify the transit of a species of animals from one locality or latitude to another. The passage is usually to and fro between a temperate and a cold climate, or a temperate and a warm climate; and this periodical change of abode is most general in the arctic species of animals, and least prevalent in the tropical species. The most remarkable, rapid, and extensive migrations are performed by birds, owing to their ability to maintain a long and rapid flight through a medium which offers the least opposition to their progress. The inequalities and alternations of land and water upon the surface of the earth, and the presence of enemies and other dangers, would appear to form insurmountable obstacles to any general or extensive migration of quadrupeds; yet the musk-ox, the rein-deer, the arctic fox, &c., are driven southward by the rigours of the polar winter, and return to the extreme latitudes in the summer season. Less regular, but not less general migrations, take place among the quadrupeds which range the tropical continents in seasons of unusual drought. Vast herds of oxen, goaded by thirst, are thus impelled over the South American Pampas in quest of water. The valleys of the warmer parts of Africa are occasionally traversed by hosts of quadrupeds, migrating under the same stimulus. Lions and other carnivora have on these occasions been seen absolutely hemmed in by antelopes, gnus, and other herbivorous species which constitute their prey. The Scandinavian LEMMING, however, is the species of quadruped most remarkable for its migration. But the migratory periods are not regular; nor are the immense bodies that travel in a given direction ever known to return. In this respect their migration resembles rather that of the locusts among insects than the true and regular migration of birds, which appears to be influenced mainly by the necessity of providing sufficient food for their young, and by the temporary continuance of such food in the climates best suited for propagation.

The arctic and northern seas, which teem with life during the long unbroken day that constitutes the summer season of such latitudes, are resorted to by numerous aquatic birds during the breeding season; and these birds regularly migrate southward when the severities of winter set in. In temperate latitudes, as those of England, certain spring and summer months are peculiarly favourable to the production of insects in their different stages; and our island is accordingly frequented by many insectivorous birds, which leave warmer latitudes during these months to breed and rear their young with us. As a general rule, it may be stated that birds migrate southward in the northern hemisphere for food principally; but that they migrate northward both to feed and breed. The most remarkable summer immigrants that visit England from the south, and breed in this island, are the swifts, swallows, cuckoo, nightingale, and many other insectivorous Passerine birds; and it is remarkable that the males of the song birds always precede the other sex in their vernal flight.

Mikado. [TYCOON.]

Mildew (in Ger. mehlthau, *rust on corn*). This term is generally applied to a particular mouldy appearance on the leaves of plants, produced by innumerable minute fungi, which, if not checked in their growth, occasion the decay and death of the parts on which they grow, and sometimes of the entire plant. It is common on wheat, and on the hop; and in gardens on the leaves of the peach, the nectarine, and other fruit trees. The causes favourable to the production of mildew are a rich soil and a moist atmosphere, without a free circulation of air or sunshine; or sometimes an excessive dryness, which checks the action of the natural functions of the vegetable organs. In agriculture, this parasitical disease is generally considered irremediable; but in gardening, it may be checked by the application of sulphur in the form of powder to the leaves covered by the fungi, this being found to destroy them without greatly injuring the leaf.

(Lat. mille passuum, *a thousand paces*). The Roman pace being 5 feet, and a Roman foot being equal to 11·62 modern English inches, it follows that the ancient Roman mile was equivalent to 1,614 English yards, or very nearly 11·12ths of an English statute mile.

The English statute mile was defined (incidentally, it would seem) by an Act passed in the 35th year of the reign of Queen Elizabeth, by which persons were forbidden to build within three *miles* of London; and the mile was declared to be 8 furlongs of 40 perches of 16½ feet each. The statute mile is, therefore, 1,760 yards, or 5,280 feet. [MEASURES.]

The mile is used as an itinerary measure in almost all countries of Europe, particularly those which were formerly under the sway of the Romans; but it is very difficult to conjecture the causes which have given rise to great diversity of its values. It has been supposed that in some countries the Roman mile was confounded with the ancient Celtic league.

The following table, given on the authority of Kelly's *Cambist*, shows the length of the modern mile, and also the league, of various countries, and their relation to the English statute mile:—

	Yards	Stat. miles
Modern Roman mile	1,628	·925
English statute mile	1,760	1·000
Tuscan mile	1,808	1·027
Ancient Scottish mile	1,984	1·127
Irish mile	2,240	1 273
French posting league	4,263	2·422
Spanish judicial league	4,635	2·634
Portugal league	6,760	3·841
German short mile	6,859	3·897
Flanders league	6,864	3·900
Spanish common league	7,416	4·214
Prussian mile	8,237	4·680
Danish mile	8,244	4·684
Dantzic mile	8,475	4·815
Hungarian mile	9,113	5·178
Swiss mile	9,153	5·201
German long mile	10,126	5·753
Hanoverian mile	11,559	6·568
Swedish mile	11,700	6·648

According to the same authority, the Arabian mile is 2,148 yards, the Persian parasang 6,086 yards, the Russian verst 1,167 yards, and the Turkish berri 1,826 yards. The English geographical mile is 1-60th of a degree of latitude, or about 2,025 yards; the geographical league of England and France is 3 such miles, or 6,075 yards; and the German geographical mile is equal to 4 English geographical miles, or 8,100 yards. See a disquisition on the history of the English mile in the *English Cyclopædia*.

Milfoil. One of the English names of the Yarrow, *Achillea Millefolium*, a bitter native herb, whose leaves have been used medicinally.

Miliaria (Lat. from milium, *millet seed*). A disease attended by an eruption resembling millet seed. Miliary fever.

Miliola. The generic name applied by Lamarck to an extinct mollusc, or zoophyte, which has left its small foraminiferous multilocular shell in great numbers in the strata of many quarries in the neighbourhood of Paris.

Military Train. A regiment organised after the Crimean war, for the purpose of performing the transport duties of the army on a campaign. Its total strength of all ranks for 1865 is upwards of 1,800. The regiment ranks before the foot guards, and immediately after the royal engineers.

Militia (Lat. *military service*). A body of citizens regularly enrolled, and trained to the exercises of war; but in this kingdom not liable to serve out of the limits of Great Britain and Ireland, except by the voluntary act of any particular regiment. The militia is now placed under the lords-lieutenant of counties, appointed by the sovereign, who have power to call them out and train them annually. It is subject to the provisions of the Mutiny Act and Articles of War. When called into active service, the officers rank with those of the regular army, but as juniors of each grade. All persons not labouring under bodily infirmity, or specially excepted, are liable to be chosen for private militiamen, by ballot, in each parish, and are compelled under a penalty of 10*l.* to serve either personally or by substitute. Volunteers paid by consent of the inhabitants, by parish assessments, may, however, be substituted for balloted men. The militia is trained and exercised by battalions or regiments twice in a year, for fourteen days at a time, or once in a year for twenty-eight days, as the lords-lieutenant may decide.

The national guard may be said now to constitute the militia of France. [GUARD, NATIONAL.] In Austria and Prussia it is called *landwehr*; and in the latter country receives full pay during a certain part of every year when it is in exercise. Many unsuccessful efforts were made by German sovereigns, during the wars of the last century, to organise bodies of troops which should be as cheaply raised as militia, and yet be serviceable in foreign war. Frederick the Great used such troops for garrison service. In Prussia every man who has served his three years, or a single year in certain cases, of lawful service in the standing army, belongs to the first class of the landwehr until his thirtieth year; and from that time until his fortieth to the second class.

Milk (Ger. milch, Lat. mulgere, Gr. ἀμέλγειν, *to milk*). This important fluid, which is secreted by appropriate glands in the breasts of the Mammalia, constitutes the entire food of the young animal for many months after birth. Its composition, therefore, is of great interest in a physiological and chemical point of view, inasmuch as it must contain within itself all those ultimate and proximate constituents which are required for the support of life and the growth of the body, both in respect to the

herbivorous and carnivorous tribes. We may, therefore, take *cow's milk* as the type of this secretion; for although the relative proportions of the constituents may vary in other animals, and indeed in the same animal under different conditions of health and diet, their leading characters are retained throughout. The composition and sources of these proximate elements are stated under their respective heads, so that it will only be necessary here to refer to their relative proportions as existing in milk, and to the manner in which they affect its general properties.

The specific gravity of milk varies from 1·018 to 1·045; its density being diminished in proportion to the quantity of butter, and increasing in proportion to the casein. In its healthy state, milk is almost neutral, especially under the influence of mixed food; but it has been observed, that in herbivorous animals it is sometimes slightly alkaline, and slightly acid in the carnivora. Its average composition may be inferred from the following table:—

Water	873·00
Casein	48·62
Sugar	43·90
Butter	30·00
Phosphate of lime . .	2·31
Phosphate of magnesia . .	0·42
Phosphate of iron . . .	0·07
Chloride of potassium . .	1·44
Chloride of sodium . .	0·24
	1000·00

The yellowish translucency of milk depends upon its butyraceous particles. When examined under the microscope, it presents the appearance of transparent globules floating in a transparent fluid; and the globules seem to consist of butter contained in a very thin investing membrane, which may be broken mechanically, as in the act of churning, or dissolved by adding a few drops of a solution of caustic potash to the milk, which in either case sets the oil free. When allowed to remain for some hours at rest, these globules collect upon the surface, in the well-known form of *cream.* [BUTTER; CREAM.] But in addition to the butter thus suspended in or diffused through the milk, it holds two important principles in aqueous solution; namely, milk-sugar, and curd or casein: the former, like butter, a well-defined non-azotised substance [LACTINE]; the latter an azotised principle, of the albuminoid type [CASEIN; CHEESE], and entirely replacing the albumen (or *lacto-protein?*) which is contained in the so-called colostrum, or the milk first formed immediately after the birth of the young animal. In reference to the saline constituents of milk, it may be observed, that in addition to the phosphates, which are essential to the formation of bone, there are the chlorides of potassium and sodium, and a trace of oxide of iron. Some notion of the variable composition of the milk of different animals may be formed from the following statement given by Regnault:—

	Cow	Ass	Goat	Mare	Human
Water . . .	87·4	90·5	82·0	89·6	88·6
Oil or butter .	4·0	1·4	4·5	traces	2·6
Lactine and soluble salts . .	5·0	6·4	4·5	8·7	4·9
Casein, albumen, and fixed salts .	3·6	1·7	9·0	1·7	3·9
	100·0	100·0	100·0	100·0	100·0

The spontaneous souring of milk and the action of the gastric juice upon it have been elsewhere noticed. For the details of its physiological and chemical history, we must refer to other authorities, more especially to Pélouze and Frémy (*Traité de Chimie Organique* iii. 616), and Watts's *Dictionary*, art. 'Milk.'

Milk Fever. [PUERPERAL FEVER.]

Milk Quartz. A variety of Quartz of a milk white colour, chiefly occurring in Greenland.

Milk Vessels. In Plants, the anastomosing tubes lying in the bark, or near the surface of plants, in which a white turbid fluid is secreted.

Milk-tree. A term sometimes applied to certain trees, whose trunks yield a milky fluid when wounded. The name is applied more particularly to those species in which the fluid is harmless and fit for food—an uncommon circumstance among lactescent plants, whose secretions are generally dangerous. In the Caraccas there is one sort, the *Palo de Vaca*, or Cow-tree of Humboldt, whose milk is a common article of diet among the natives; this is the *Brosimum Galactodendron*, formerly called *Galactodendron utile*, one of the *Artocarpaceæ*. The Kiriaguma of Ceylon, *Gymnema lactiferum*, is another milk-tree; its milk is pleasant to the taste, and used for domestic purposes. In the Canaries, the Tabayba dolce, *Euphorbia balsamifera*, yields a juice which is similar to sweet milk, and when thickened into jelly is eaten as a delicacy, though the *Euphorbias* are generally an acrid poisonous race.

Milk-weed. In Botany, the common name for the genus *Asclepias.*

Milkwort. The common name applied to *Polygala vulgaris*, a native plant, possessing bitter qualities.

Milky Way or **Via Lactea.** [GALAXY.]

Mill Board. A paper employed to make the joints of some kinds of pipes. The mill board is cut to the size of the pipe, and then smeared over with white lead, and pressed up to its work by means of bolts. In order to make it resist the action of moist heat, the mill board is sometimes baked in boiled oil, and again covered with this oil laid on with a brush before being applied.

Millennium (Lat. mille anni, *a thousand years*). The reign of Christ with His saints upon earth for the space of a thousand years; an idea derived from a passage in the Apocalypse, and not uncommonly entertained by Christians in all ages. It was maintained by Justin Martyr, Irenæus, Tertullian, and others, and refuted by Origen. (Gibbon, ch. xv.; Bertholdt, *Christologia Judæorum*; Eisenmenger, *Das Entdeckte Judenthum.*)

Millepores (Lat. mille, *a thousand*; porus, *a pore*). A tribe of Lithophytous Polypes,

including those in which the calcareous axis is perforated by extremely numerous pores.

Millerite. Native sulphide of nickel. It occurs in delicate capillary crystals of a brass- or bronze-yellow colour, with a grey or iridescent tarnish in nodules of clay iron-stones in the coal measures of Glamorganshire and elsewhere. Named after Professor W. H. Miller of Cambridge.

Millet (Lat. milium, Fr. millet). The name given to various grain-bearing grasses, some of which attain a height of from sixteen to twenty feet in favourable situations. The principal Millets are *Panicum miliaceum*, *Setaria italica*, and *Sorghum vulgare*. They are cultivated as grain, and sometimes employed as a substitute for rice or sago by the poorer classes, but more frequently used for feeding chickens and domestic animals. Millet is cultivated to a considerable extent in France, Switzerland, and Southern Germany, but most extensively in Egypt, Syria, Nubia, China, and Hindustan. The climate of England is not sufficiently dry and warm to allow of its cultivation.

Million. A thousand thousand. [NUMERATION.]

Millipedes (Lat. millepeda, *with a thousand feet*). Several insects formerly used in medicine were included under this name: amongst them the *Armadillo vulgaris*, or *pill millipede*: the *Porcellio scaber*, or *Sclater* of the Scotch; the *Oniscus Asellus*, or common *Woodlouse*.

Millstone Grit. A coarse grit stone or conglomerate, more or less compact, belonging to the upper or newer part of the great carboniferous system, and immediately underlying the coal measures in the principal coal districts. Occasionally coal is found regularly bedded with the gritstone, but the seams are poor and thin. The millstone grit is for the most part a local accumulation from 150 to 180 yards thick, and it is widely spread in the northern counties of England and Wales, its outcrop being traced with great regularity. It yields much excellent building material, and is readily distinguished from the coal grits. Many parts of it consist of quartzose conglomerates, more or less coarse in texture.

Lead veins occur in millstone grit in Derbyshire and Yorkshire, but they are more productive in the limestones below. Excellent millstones have been obtained from it, and good firestone for the hearths of iron furnaces. The upper beds are thin, and are used for paving stones, and occasionally for roofing.

There is no exact foreign representation of this division of the carboniferous system.

Miloschine. A chromiferous clay found in soft amorphous masses of an indigo-blue or greenish colour at Rudniak in Servia. Named after Prince Milosch Obrenowitsch.

Milvines. A family of Raptorial birds, of which the kite (*Milvus*) is the type. [KITE.]

Mime (Lat. mimus; Gr. μῖμος, *an imitator*). The name given by the Greeks to a species of dramatic entertainment, and to the actors by whom it was performed. It consisted chiefly of a rude representation of common life, and resembled the modern farce or vaudeville in its character and accompaniments. Sophron of Syracuse, who lived about 400 years before the Christian era, is considered to have brought this species of composition to perfection. (The *Museum Criticum*, No. 7, contains several fragments of mimes by Sophron.) At what period it was first practised at Rome cannot be precisely ascertained; but in the time of the emperors, and even under Augustus, this species of entertainment had attained a high degree of popularity. Among the Romans it was of a still more farcical character than among the Greeks, and bordered more upon such mountebank representations as *Punch and Judy* among ourselves, and the *Fantoccini* of the Italians. Mimes originally formed a part of the usual theatrical exhibitions; but they were soon introduced by the wealthy Romans into their private entertainments to divert their guests. At Rome they also held a prominent place at funerals, on which occasions they gave a burlesque representation of the life of the deceased. Thus, Suetonius tells us that the archmime Favo was present at the funeral of Vespasian: 'Sedet in funere Favo archimimus, personam ejus ferens, imitansque, ut mos est, facta et dicta vivi.'

Mimetite (Gr. μιμητής, *an imitator*; from its resemblance to Pyromorphite). A native arseniate of lead mixed with chloride and phosphate of lead. It was formerly worked as an ore of lead at Drygill in Cumberland, and was used in the manufacture of flint glass, to which it imparted peculiar brilliancy.

Mimosa. A very extensive genus of *Leguminosæ*, chiefly remarkable as containing some of the plants known as *Sensitive Plants*, in which what is called vegetable irritability is very fully displayed. The species called *M. pudica* and *M. sensitiva*, both common in hothouses, afford striking illustrations of this curious peculiarity.

Mimotannic Acid. The astringent acid of *catechu*, called also *catechu-tannic acid*.

Mimus (Lat. *a mimic*). A genus of Passerine birds, separated by Boié from the thrushes (*Turdus* of Linnæus) on account of the more elongated form of the body, and particularly of the tail, the shorter wings, and more curved upper mandible. The type of this genus is the celebrated MOCKING BIRD.

Mimusops (Gr. μῖμος, *a mimic*; ὤψ, *the face*). This genus of *Sapotaceæ* includes several species which yield hard durable heavy timber. Among these are *M. hexandra* in Peninsular India, and *M. Elengi* and *M. indica* in Ceylon, where the wood is used for house-building. The fruits of *M. Elengi* are eaten, its seeds afford abundance of oil, and a perfume is distilled from its flowers.

Mina (Gr. μνᾶ). A weight and coin in use among the Greeks; it varied in different states. The Attic mina, which is most frequently mentioned, was heavier than the Roman pound by about four drachmæ. Each mina contained 100

drachmæ, and was itself contained 60 times in an Attic talent. The coin was worth a little more than 3*l.* of our money.

Minaret (Arab. *manarah, a lantern*). A slender and lofty turret in the mosques of Mohammedan countries, used for the purpose of summoning the people to prayers, and consequently answering the purpose of the belfry in Christian churches. They are usually surrounded with projecting balconies, and are crowned with spires surmounted by a crescent.

Mindererus' Spirit. Solution of acetate of ammonia, first recommended as a febrifuge by Raymond Mindererus, a physician of Augsburg.

Mines and Minerals, Law of. By the law of England all minerals are part of the freehold of the soil under which they are found, with the exception of gold and silver, which are said to belong to the crown. But, by 1 Wm. & Mary c. 50, no mine of copper or lead is adjudged a royal mine, though silver be extracted. Trustees are not now justified, without special authority, in selling mines apart from the surface, without the sanction of the Court of Chancery (stat. 25 & 26 Vict. c. 108, which confirmed previous sales). Lessees, tenants for life, and other partial owners of land cannot lawfully dig mines unless exempted from liability for waste. Mines are not rateable to the relief of the poor, with the exception of coal mines; the latter being expressed in the statute of Eliz., the former are held to be excluded by implication. But quarries are rateable; and the distinction between a mine and a quarry is taken to be, not the nature of the mineral extracted, but the mode of working: thus, a mine of limestone worked by a shaft is not rateable. The law of mines and minerals is subject to a variety of local customs, of which those of Devon and Cornwall are the most remarkable. [STANNARIES.]

According to the law of France and most continental countries, ownership of the soil does not carry with it absolute ownership of mines, and these may be made the subject of *concession* by government to others than the owner, paying the latter a stipulated retribution.

Mines, Military. Excavations made in the rampart of a fortress, or underground, to contain gunpowder or gun cotton, which being exploded forms a breach in the rampart, or destroys any of the enemy's troops or works in its vicinity. Mines are *offensive*, in which case they are constructed by the besiegers of a fortified place; or *defensive*, in which case they are called *counter-mines*, and are executed by the besieged. The cavity for the powder is called a *chamber*, the approach to this a *gallery*, or in very small mines, a *branch*. The systems of mines and counter-mines are fully explained in the article 'Mining' in the *Aide Mémoire to the Military Sciences*, and briefly in Knight's *English Cyclopædia*.

Mineral Adipocere. *Mineral tallow, Hatchettin.* A greasy bitumen, found in the argillaceous ores of iron.

Mineral Caoutchouc. The elastic bitumen found at Castleton in Derbyshire.

Mineral Carbon or **Mineral Charcoal.** Names given to the thin fibrous layers of nearly pure carbon of a silky-black colour which occur in the coal measures of Whitehaven and elsewhere. By the miners it is called *mother of coal.*

Mineral Chameleon. A manganate of potash, obtained by fusing a mixture of nitre, or chlorate of potash, and black oxide of manganese. So called from the variety of colours which its hot aqueous solution successively exhibits. [MANGANESE.]

Mineral Green. Carbonate of copper, obtained by precipitating a hot solution of sulphate of copper by carbonate of soda.

Mineral Oil. [OILS.]

Mineral Pitch. [ASPHALT; BITUMEN.]

Mineral Veins. Fissures and crevices occur in all rocks, and are in many cases filled up with crystalline material, either segregated from the enclosing rock or brought in from a distance. Such fissures are called *mineral veins.* They are almost always more or less systematic, being found in sets parallel or at right angles to each other, or making some definite angle with the axis of elevation. When such mineral veins occur on a large scale in rocks that have been metamorphosed, and in districts where granite, micaceous schists, crystalline limestone, slate, and other altered rocks abound, they assume an important character, and are often found to contain in some sets of veins either native metals, or the oxides, carbonates, chlorides, or sulphurets of metals, which appear to be present according to the action of some great law not yet clearly understood, but having reference to the history of the rock during or subsequent to its metamorphosis. Such veins are called *lodes*, or metalliferous veins. [LODES.]

Veins are generally limited in length and breadth, but the limits cannot be easily traced, as the vein often dies away and reappears. In depth it is not easy to say how far they are limited, though in this respect also there seems to be a practical barrier, and a check to their productive power, if we may accept the general results of experience in deep mines. This conclusion, however, must be accepted with many reservations and much caution.

Veins are of various kinds: 1. Simple crevices, *rake veins*, filled with ore and earthy minerals, crossing all the rocks indefinitely, and being, in fact, mere cracks of the earth's surface. Such cracks in South America have been followed for fifty miles. They are often accompanied by other cracks parallel to them or nearly so, but with which they have no connection. They are often, but not always, wider at the surface than in the depth.

2. *Slip veins*, or veins accompanying a fault. These are often more complicated, as connected with mechanical disturbances and disruption of the rock. Such veins often diverge into strings, and the metallic produce is di-

minished. They are generally in systems, and crossed by other veins. They are often much less vertical than the simple crevices. Such veins do not always traverse the strata indefinitely; and when they do, the state of the vein depends much on the nature of the stratum in which it occurs.

3. *Pipe veins* are irregular cavities opening into each other, and running down into the earth, often connected with disturbances and faults, but not necessarily continuous with them. Pipe veins usually cross the stratification.

4. *Flat veins* are spaces between beds containing ore. These often expand into large spaces resembling pipe veins, but differ from them by having a manifest reference to the bedding.

The veins above described chiefly affect stratified rocks; but in granite, porphyry, and all varieties of slate and schist, there are others on a larger scale and systematically arranged.

There is no special order of metals in mineral veins, although in every mining district there is a certain amount of uniformity in this respect. Thus in Cornwall the tin veins, copper veins, and lead veins rarely interfere one with another, and the important veins are pretty clearly defined. Iron is very generally found mixed with silica near the top or outcrop of a vein, forming what is called a *gossan*; and gold is also common in such positions. Copper occurs in slaty and schistose districts next in order of depth, copper pyrites mixed with iron pyrites, decomposed and converted into carbonate, showing itself near the surface. Tin generally accompanies granite, and appears in granitic veins. Silver when unmixed with lead is also found in granite. Lead and zinc, the former often with much silver, occur combined with sulphur in limestones; the latter, either carbonate or sulphuret, also in limestones. Few valuable minerals are found in sandstone, though there are not wanting important exceptions.

Mineral veins crop out at the surface, and are generally known by a metalliferous appearance, often very slight, in the quartz of which they are formed. They are also sought for by mining operations. Their contents are rarely uniform, nor is the law of their formation or filling clearly understood. It is probably connected with the passage and circulation of magnetic currents through the earth's crust, and everything leads to the conclusion that the filling is an operation constantly and incessantly going on in all parts of the earth. The selection of material, no doubt, depends on the action of laws perfectly intelligible, and these we may expect some day to discover. At present they are very obscurely guessed at even by the most intelligent.

Mineral Waters. This term is applied to certain spring waters containing so large a proportion of foreign matter as to be unfit for ordinary use.

Mineral waters may, in most cases, be artificially prepared by the skilful application of the knowledge derived from analyses, with such precision as to imitate very closely the native springs. When the various earthy or metallic constituents are held in solution by carbonic acid, they should be placed along with their due proportions of water in the receiver of the aërating machine, and then the proper quantity of gas should be injected into the water. Sufficient agitation will be given by the action of the forcing-pump to promote their solution. (Ure's *Dict. of Arts, &c.*)

The following table shows the composition of several of the principal mineral springs of Europe:—

Tabular View of the Composition of the Principal Mineral Waters of England.
One Pint (Wine Measure) contains the following Ingredients:—

Waters	Gases			Carbonates			Sulphates			Muriates			Oxide of Iron	Silica	Temperature	Total of Saline Contents	Authority
	Nitrogen	Carbonic Acid	Sulphuretted Hydrogen	Carbonate of Soda	Carbonate of Magnesia	Carbonate of Lime	Sulphate of Soda	Sulphate of Magnesia	Sulphate of Lime	Muriate of Soda	Muriate of Magnesia	Muriate of Lime					
Sulphurous	c.i.	c.i.	c.i.	grs	grs	grs	grs	grs	grs	grs	grs	grs	grs	grs			
Harrogate	0·8	1·	2·5		0·7	2·5	..	1·5	..	77·	11·	1·5	.	.	cold	94·	Garnet
Moffat	0·5	0·6	1·2	..	.	..	.	..		4·5		...	..	..	do.	4·5	Ditto
Cheltenham sulphur spring	..	..	1·5	.	..	.	25·5	5	1·2	55		.	0·5	..	do.	65·	Parkes & Brande
Saline																	
Cheltenham pure saline	..	..	.. .	..	.	.	15	11	4·5	50	.		.	..	do.	80·5	Ditto
Bristol	.	5·5	.. ..		..	1·5	1·5		1·5	0·5	1·	..	.	..	74°	6·	Carrick
Buxton	0·2	.	.. .	.		1·5		.	0·5	0·2	..	..	0·03	..	82°	1·83	Pearson
Bath		1·2	.. .		.	0·8	1·5		9·	3·5	..	..	a trace	0·2	110°	14·6	Phillips
Scarborough	.	..	..	.	..	a trace	20		9		..	..	ditto	..	cold	2·9	Saunders
Kilburn	..	5·5	8·5?	..	0·5	1	12	·7	5·5	2·5	5·5	0·2	ditto	..	do.	64·2	Schmeisser
Leamington New Bath	0·4	a trace	a trace	..		..	19·	.	14·	53	1·5	..	0·8	..	do.	88·3	Lambe
Leamington Old Bath	0·5	..	ditto	.	.	.	7·5	7	18·	41	..		.	..	do	73·5	Ditto
Chalybeate																	
Tunbridge	0·59	1·	a trace of oxygen	.		0·05	.	.	0·17	0·50	0·03	0·05	0·28	..	do	0·56	Scudamore
Cheltenham chalybeate	..	2·5	.. .	0·5	..		22·7	6·	2·5	41·3	..	..	0·8	..	do.	73·8	Parkes & Brande
Brighton	..	2·2			.			..	4	3·	0·75	..	1·4	0·11	do.	9·20	Marcet

Tabular View of the Composition of the Principal Mineral Waters of Germany.

Ingredients found in 16 oz. of Water in a dry state, in grains	Carlsbad	Ems	Marienbad. Kreutzbr.	Auschowitz. Ferdinands-brunnen	Eger. Franzensbr.	Pyrmont	Spa	Geilnau	Selters	Seidschutz	Pullna
Carbonate of soda . .	9·695	10 750	8·26	6·197	5·00	.. ..	0·7575	6·6210	6·155		
Sulphate of soda . .	19·695	.. ..	39·72	22·544	25·50	2·14566	0·0375	0·0420	.. ..	25·4960	125·6
Muriate of soda . .	7·975	7·634	12·45	8·996	7·96	.. ..	0·44949	0·5450	17·292		
Sulphate of potash . .	.. ..	0·540	0·93	.. ..	0·93	0·04194	0·07909	0·2872	0·397	4·8940	4·8
Muriate of potash . .	.. ..	0·045	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0·358		
Carbonate of lime . .	2·37	1·1407	4·1300	4·016	1·847	5·98824	0·9850	2·9705	2·1870	6·8060	0·77
Sulphate of lime . .	.. ..	.. ..	.. ..	.. ..	.. ..	7·22132	.. ..	.. ..	.. ..	1·5050	2·6
Sub-phosphate of lime . .	0·0017	.. ..	.. ..	.. ..	0·014	.. ..	0·01366	.. ..	.. ..	0·0156	0·0035
Fluate of lime . .	0·024	0·00192	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0·0018		
Carbonate of magnesia .	1·369	0·7887	3·0560	2·4	0·600	0·32352	1·12278	2·1709	1·3780	1·0980	6·406
Sulphate of magnesia .	.. ..	.. ..	.. ..	.. ..	.. ..	2·69752	.. ..	.. ..	.. ..	85·1380	93·086
Muriate of magnesia .	.. ..	.. ..	.. ..	.. ..	.. ..	1·12664	.. ..	.. ..	.. ..	1·6500	19·666
Nitrate of magnesia .	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	7·9070	
Alumina .	.. ..	.. ..	0·0075	.. ..	.. ..	.. ..	.. ..	0·0247			
Sub-phosphate of alum .	0·0024	0·0018	.. ..	.. ..	.. ..	0 01478	0·00851	.. ..	0·0027	0·0117	
Carbonate of strontian .	0·007	0·0107	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0·0192		
Sulphate of strontian .	.. ..	.. ..	.. ..	.. ..	.. ..	0·02365	.. ..	.. ..	.. ..	0·0468	
Carbonate of barytes .	.. ..	0·0029	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0·0019		
Silica . .	0·577	0·4139	0·8800	0·669	0·568	0·49 89	0·4985	0·2695	0 302	0 1200	0 176
Carbonate of iron . .	0·0278	0·026	0·1760	0·4	0 350	0·42846	0·3751	.. ..	.. ..	0·0127	
Carbonate of manganese	0·006	0 0037	0·0065	0·092	0·006	0·04852	0·0519	.. ..	.. ..	0·0042	
Total . .	41·9239	21·35932	69 616	45·314	42·775	20·55412	4·35903	12 9288	28·0946	130 6845	251·3075
Carbonic acid gas in 100 cubic inches .	58	51	125	149 56	154	160	136	163 5	130	6·4	6 9
Temperature (Fahr.) . .	Sprud. 165° Neub. 138° Mühl. 128° Ther. 122°	Kess 117° Krän. 84°	53°	49°	53°	56°	50°	51°	58°	58°	58°
Analysed by	Berzelius	Struve	Struve	Steinmann	Struve	Struv	Struve	Struve	Struve	Struve	Struve

Mineral Yellow or **Patent Yellow.** A compound of oxide and chloride of lead, obtained by digesting powdered litharge in a solution of common salt, washing, drying, and fusing the product.

Mineralisers. The substances with which metals are combined in their ores. Thus, in the native oxides, oxygen is called the mineraliser; sulphur is also a very common mineraliser, as in copper pyrites, galena, &c.

Mineralogy. This name is given to the science which teaches us to distinguish mineral bodies from each other, and makes us acquainted with their mode of occurrence in the earth, the manner in which they have been formed, the changes which they have undergone since their formation, their composition, properties, relations, and uses; and, also, the mode of describing and arranging them.

It comprises, therefore, all inorganic natural objects, or all those substances found in or on the earth which exist by virtue of chemical and cohesive forces, in contradistinction to substances belonging to the animal and vegetable kingdoms, which are possessed of a vitality upon which their existence depends. This being the case, it follows necessarily that the science of mineralogy includes the liquids and gases which occur naturally on the surface or in the interior of the earth—because, although the term *mineral* may not be strictly applicable to them, they are not the less natural substances which cannot be comprised amongst those which are formed by the aid of vital forces.

The study of mineralogy should, therefore, precede, and to a certain extent form the groundwork of the science of geology, since it treats of and describes the individual qualities of the simple minerals which enter into the composition of the materials forming the earth's crust; while geology treats of them as they are associated in the structure of the earth, of which they form the rocks and soils.

'There is no branch of science,' says Sir J. Herschel, 'which presents so many points of contact with other departments of physical research, and serves as the connecting link between so many distant points of philosophical speculation, as this. To the geologist, the chemist, the optician, the crystallographer, it offers especially the very elements of their

knowledge, and a field for many of their most curious and important enquiries; nor, with the exception of chemistry, is there any which has undergone more revolutions, or been exhibited in a greater variety of forms. To the ancients it could scarcely be said to be at all known; and, up to a comparatively recent period, nothing could be more imperfect than its descriptions, or more inartificial and unnatural than its classifications. The more important minerals in the arts, indeed—those used for economical purposes, and those from which metals were extracted—had a certain degree of attention paid to them for the sake of their utility and commercial value, and the precious stones for that of ornament; but until their *crystalline forms* were attentively observed, and shown to be determinate characters, on which depêndence could be placed, no mineralogist could give any correct account of the real distinction between one mineral and another. It was only, however, when chemical analysis had acquired a certain degree of precision and universal applicability, that the importance of mineralogy as a science began to be recognised, and the connection between the external characters of a stone and its ingredient constituents brought into distinct notice.'

Mineralogy is chiefly based upon a study of the external and physical characters of minerals, and upon a knowledge of their chemical composition—the characters of a mineral including everything which can be the subject of an observation by means of which it can be recognised or identified.

But even this knowledge is insufficient to afford a complete mastery of the subject, which must be founded on a knowledge of crystalline form and structure [CRYSTALLOGRAPHY] as well as of chemical composition. Hence the subject may be considered under the heads of Physical Characters, Crystallographic Characters, and Chemical Composition.

The general characters of minerals may be considered under the following heads: 1. Those depending on light, as Colour, Transparency, Lustre, or on optical properties, as Refraction, Polarisation, &c. 2. Those dependent on physical properties, as Specific Gravity, Phosphorescence, Fluorescence, Electricity, Magnetism. 3. Those dependent on cohesion, as Frangibility or Tenacity, Hardness, Toughness, Fracture, &c., and on various other properties, as Stain, Streak, Taste, Odour, Feel, Adhesion to the tongue, &c.

With regard to the classification of minerals, although it is fully agreed that a knowledge of chemical composition must form the basis of a perfect system of classification, it is found in practice that an arrangement founded solely on chemistry is attended with much inconvenience, and that for practical purposes an artificial system will prove to be more useful.

The most generally useful system of classification for all working purposes is that given below, and extracted from the Introduction to Bristow's *Glossary of Mineralogy*. Such a mode of arrangement may be adopted with advantage, both for its simplicity as well as its practical utility, being based on chemical composition with such modifications only as may be considered likely to increase its usefulness.

NON-METALLIC MINERALS.

CLASS I.

CARBON AND BORON.

CARBON *and its Natural Compounds*.

Diamond
- Boort.

Graphite.
- Tremenheerite.

Coals.

Non-bituminous Coal.
- Anthracite, or Stone Coal.

Bituminous Coal.
- Common Coal.
- Albert Coal, or Albertite.
- Cannel Coal. }
- Horn Coal. }
- Torbanite. }

Brown Coal.
- Lignite.
- Jet.
- Surturbrand.

Dysodile.

Mineral Oils and Resins.

Naphtha.
Petroleum.
Bitumen.
Elaterite, or Elastic Bitumen.
Asphalt.

Amber.
Copaline.
- Highgate Resin.

Scleretinite.
Retinite.
Piauzite.
Walchowite.
Krantzite.
Berengelite.
Middletonite.
Anthracoxene.
Pyropissite.
Phylloretine.
Ozokerite.
Hatchettine.
Idrialine.
Tekoretine.
Scheererite.
Könlite.
- Könleinite

Baikerite.
Fichtelite.
Guyaquillite.
Hartite.
- Hartine.
- Ixolite.
- Bog Butter.

Bathvillite.

Inflammable Salts.

Dinite.
Dopplerite.
Mellite.

BORON.

Sassolin, or Boracic Acid.
Larderellite, or Borate of Ammonia.
Borax, or Borate of Soda.
Hayesine, or Borate of Lime.
Rhodizite.

Borate of Lime and Soda.

Cryptomorphite.
Tinkalzite.

Boracite, or Borate of Magnesia.
- Stassfurthite.

Szaibelite.

Hydroboracite.

Lagonite.

Warwickite.

CLASS II.

Sulphur and Selenium.

SULPHUR.

Native Sulphur.
Selen-Sulphur.

SELENIUM.

Clausthalite.
- Selenbleikupfer.
- Selenkobaltblei, or Tilkerodite.

Onofrite.
Lehrbachite.
Berzelianite.
Naumannite.
Selenkupferblei.
Eukairite.

CLASS III.

Haloids and Salts.

AMMONIA.

Ammonia-Alum.
- Tschermigite.

Bicarbonate of Ammonia.
Mascagnine or Sulphate of Ammonia.
Sal Ammoniac or Muriate of Ammonia.

POTASH.

Nitre, or Nitrate of Potash.
Glaserite, or Sulphate of Potash.
Misenite.
Sylvine, or Muriate of Potash.
Jarosite.
Polyhalite.

SODA.

Trona, or Carbonate of Soda.
- Urao.

Natrolite.
- Thermonatrite.

Thenardite.
Glauber Salt (Sulphate of Soda).
- Exanthalose.

Lecontite.
Glauberite.
Nitrate of Soda, or Nitratine.
Loweïte.
Common or Rock Salt.
- Martinsite.

Reussite.
Stercorite.

BARYTA.

Witherite.

Baryto-calcite.

Barytes.
- Bolognese Stone.
- Hepatite.
- Allomorphite.
- Cawk.

STRONTIA.

Strontianite.
- Emmonite.

Barystrontianite.
Celestine.

LIME.

Calc Spar, or Calcite.
Iceland Spar.
Madreporite.
Stalactite.
Stalagmite.
Oriental Alabaster.
Onyx Marble.
Eye Stone.
Travertine.
Ostreocolla.
Calcareous Tufa.
Kunkur.
Marble.
Lumachello, or Fire Marble.
Cotham, Ruin, or Landscape Marble.
Stinkstone, or Swinestone.
Agaric Mineral.
Aphrite.
Fontainebleau Sandstone.
Natro-calcite.
Plumbo-calcite.
Strontiano-calcite.
Conistonite.
- Whewellite.

Aragonite.
- Mossotite.
- Flos-ferri.
- Satin Spar.
- Sprudelstone.
- Tarnowitzite.

Dolomite.
- Conite.
- Brossite.
- Rauchkalk.
- Pearl Spar.
- Bitter Spar, or Rhomb Spar.
- Miemite.
- Predazzite.
- Brown Spar.
- Ankerite.
- Pennite.
- Gurhofite.

Apatite.
- Asparagus Stone.
- Lazurapatite.
- Moroxite.
- Phosphorite.
- Francolite.
- Odontolite.
- Osteolite.
- Talc-Apatite.
- Herderite.
- Sombrerite.
- Brushite.

Anhydrite.
- Muriacite.
- Tripe Stone.
- Vulpinite.

Selenite.
Alabaster.
- Gypsum,
- Satin Spar.
- Schaumkalk.

Dreelite.
Polyhalite.
Datholite.
Nitro-calcite.
Gay-Lussite.
Haidingerite.
Kühnite.
Romeine.

Scheelite.

Perowskite.
Rutherfordite.

Azorite.

Fluor Spar.
- Blue John.
- Antozonite, or Fetid Fluor.

MAGNESIA.

Magnesite.
- Globertite.

Nitro-Magnesite.

Magnesia-Alum.
Epsomite.
Kieserite.

Breunnerite.

Tachydrite.

Struvite.
Wagnerite.

Hoernesite.

ALUMI

Diaspore.
Hydrargyllite.
Gibbsite.
- Bauxite.

Alunogene.
- Kapnicite.

Keramohalite.
Websterite.
- Hallite.
- Paraluminite.

Potash Alum.
Alunite, or Alum-stone.
Loewigite.
Pissophane.
Svanbergite.
Amblygonite.

Wavellite.
- Lasionite.

Turquois.
Callais.
Fischerite.
- Peganite.

Lazulite.

Childrenite.

Evansite.

YTTRIA.

Phosphate of Yttria, or Xenotime.

ZIRCONIA.

Wöhlerite.
Pyrrhite.

CERIA.

Fergusonite.

CLASS IV.

EARTHS.

SILICA, ALUMINA, MAGNESIA, AND THEIR HYDRATES.

SILICA.

Anhydrous Silica, or Vitreous Quartz.

Rock Crystal.
Amethyst.
False Topaz.
Citrine.
Smoky Quartz, or Cairngorm.
Morion.
Rock Crystal with included capillary crystals of—
Titanium.
Epidote.
Amphibole.
Scales of Mica.
Chlorite.
Bitumen.
Enhydros, or Rock Crystals
Containing Water and other liquids, also Brewsterline, Amethystoline, Cryptoline, &c.
Rose Quartz.
Siderite.
Greasy Quartz.
Fetid Quartz.
Milk Quartz.
Ferruginous Quartz.
Hacked Quartz.
Potato Stone, or Geode.
Fulgurite.
Aventurine.
Prase.

Chalcedonic Quartz.

Chalcedony.
Beekite.
Saphirine.
Haytorite.
Carnelian.
Stygmite.
Sard.
Cat's Eye.
Chrysoprase.
Agate.
Moss
Ribbon Agate.
Circle Agate.
Eye Agate.
Fortification Agate.
Zoned or Banded Agate.
Variegated Agate.
Brecciated Agate.
Leonine.
Mocha Stone.
Agate Jasper.
Plasma.
Onyx.
Sardonyx.
Silicified Wood.
Flint.
Chert.
Hornstone.
Bombite.

Jaspery Quartz.

Jasper.
Red Jasper.
Yellow Jasper.
Egyptian Pebble.
Striped or Banded Jasper.
Bloodstone, or Heliotrope.
Porcellanite, or Porcelain Jasper.
Touchstone, Lydian Stone, or Basanite.
Cellular Quartz, or Float-stone.
Silicious Sinter.
Pearl Sinter, or Fiorite.
Geyserite.
Tripoli.
Sandstone.
Flexible Sandstone.
Randanite.

Hydrous Silica.

Opal.
Noble or Precious Opal.
Harlequin Opal.
Golden Opal.
Fire Opal.
Common Opal.
Wax Opal.
Menilite.
Semi-opal.
Hyalite, or Müller's Glass.
Hydrophane.
Pyrophane.
Cacholong.
Tabasheer.
Wood Opal.
Michaelite.
Opal Jasper.
Alumocalcite.

ALUMINA.

Corundum.
Sapphire.
Oriental Ruby.
Asteria, or Star Stone.
Star Sapphire.
Star Ruby.
Emery.

Rotten Stone.

Aluminate of Glucina.

Chrysoberyl.
Cymophane.
Alexandrite.

Aluminate of Magnesia.

Völknerite.
Houghite.
Spinel.
Automolite.
Candite.
Ceylanite.
Dysluite.
Chlorospinel.
Gahnite.
Hercinite.
Zeilanite.
Spinel Ruby.
Balas Ruby.
Rubicelle.

Aluminate of Lime

Prosopite.

Aluminate of Lime, Magnesia, and Iron.

Turnerite.

Aluminate of Zinc and Iron.

Kreittonite.

MAGNESIA.

Periclase, or Native Magnesia.
Brucite, or Hydrate of Magnesia.

CLASS V.

SILICATES.

SILICATES AND ALUMINATES.

Hydrous Silicates with Borate of Lime.

Datholite.
Botryolite.

Silicates of Lime.

Anhydrous.

Wollastonite, or Tabular Spar.
Chelmsfordite.

Hydrous.

Plombierite.
Okenite.
Dysclasite.
Ædelforsite.

Hydrous Silicates of Lime and Soda.

Pectolite.
Soda Table-spar.
Ratholite.
Stellite.

Hydrous Silicates of Lime and Potash.

Apophyllite
Tesselite.
Albin.
Oxhaverite.

Anhydrous Silicate of Lime, Soda, and Potash.

Osmelite.

Anhydrous Silicate of Lime and Iron.

Babingtonite.

Iron-lime Garnet.
Black Garnet, or Melanite.
Aplome.
Colophonite.
Pyreneite.

Anhydrous Silicates of Iron and Soda.

Arfvedsonite.
Achmite.

Silicates of Magnesia.

Anhydrous.

Chrysolite, or Peridot.
Monticellite.
Olivine.
Boltonite.
Forsterite.

Hydrous.

Hydrated Olivine, or Villarsite.
Noble Serpentine.
Common Serpentine.
Bowenite.
Williamsite.
Verde di Prato.
Verde di Susa.
Bagrationite.
Fibrous Serpentine.
Baltimorite.
Chrysolite.
Metaxite.
Picrolite.
Foliated Serpentine.
Antigorite.
Marmolite.

Steatite, or Soapstone.
Potstone.
Rensselaerite.
Meerschaum.
Talc.
Neolite.
Deweylite.
Hydrophite.
Schiller Spar.
Aphrodite.
Quincite.
Spadaite.
Asbestos of Koruk.
Kerolite.
Picrosmine.

Anhydrous Silicate of Magnesia with Fluoride of Magnesium.

Chondrodite.

Anhydrous Silicates of Magnesia and Lime.

Batrachite.
Jade, Nephrite, or Axe Stone.
Pyroxene.
Augite.
Ægyrine.
Arfvedsonite.
Hedenbergite.
Polylite.
Green Coccolite.
Funkite.
Diopside.
White Coccolite.
Alalite.
Fassaite.
Sahlite.
Baikalite.
Pyrgom.
Malacolite.
Breislackite.
Acanthoïde.
Jeffersonite.
Diallage, or Aluminous Augite.
Bronzite.
Hypersthene.
Schiller Spar (G. Rose).
Smaragdite.

Uralite.

Pargasite, or Noble Hornblende.
Common Hornblende.
Diastalite.
Edenite.
Gamsigradite.
Tremolite.
Peponite.
Grammatite.
Raphilite.
Anthophyllite.
Gedrite.
White or Oriental Jade.
Calamite.
Glassy Actinolite.
Asbestiform Actinolite.
Rock Wood.
Mountain Cork.
Mountain Leather.
Mountain Paper.
Asbestos.
Amianthus.
Green Diallage.
Carinthine, or Ferruginous and Aluminous Hornblende.

Hydrous Silicates of Magnesia and Iron.

Cummingtonite (var. of Anthophyllite).
Monradite.
Dermatin.
Picrophyll.

Hydrous Silicate of Magnesia, Lime, and Iron.

Diaclasite.

Hydrous Silicate of Soda, Magnesia, and Iron.

Crocidolite.

Hydrous Silicate of Cerous Oxide.

Cererite.

Anhydrous Silicate of Yttria.

Gadolinite.

Anhydrous Silicate of Glucina.

Phenakite.

Anhydrous Silicate of Glucina and Lime.

Leucophane.

Silicates of Alumina.

Anhydrous.

Staurolite.

Andalusite.
Chiastolite.

Kyanite.
Rhœtizite.
Bamlite.
Monrolite.
Sillimanite.
Bucholzite.
Fibrolite.
Worthite.
Xenolite.
Talcite, or Nacrite.

Hydrous.

Scarbroïte.
Schrötterite, or Opal Allophane.
Miloschine.
Allophane.
Porcelain Clays.
Kaolin or China Clay.
Smelite.
Fire-clay.
Pholerite.
Lithomarge, or Rock Marrow.
Carnat.
Melopsite.
Myelin.
Halloysite.
Severite.
Smectite.
Lenzinite.
Bole.
Bole of Sinope.
Ochran.
Razoumoffskin.
Salt Clay.
Agalmatolite, or Figure Stone.
Koreite.
Catlinite.
Lardite.
Dysyntribite.
Pyrophyllite.
Collyrite.
Hovite.
Dillnite.
Cimolite.
Tuesite.
Montmorillonite.

Lemnian Earth.
Malthacite.
Rock Soap.
Fuller's Earth.

Anhydrous Silicates of Lime and Fluorine.

Topaz.
Yellow Topaz.
Blue Topaz, or Brazilian Sapphire.
White Topaz.
Minas Novas.
Pingos d'agua, or Water Drops.
Pycnite.
Pyrophysalite.

Silicates of Alumina with Silicates of Potash, Soda, Lithia, Baryta, Strontia, Magnesia, Protoxide of Cerium, Yttria, Glucina, Manganese, and Protoxide of Iron.

Anhydrous Silicates of Alumina, Potash, Soda, Lime, &c.

Sodalite.
Lapis Lazuli.
Haüyne.
Noseane.
Leucite.
Nepheline.
Elæolite.
Davyne.
Cancrinite.

FELSPAR SECTION.

Orthoclase, or Potash Felspar.
Adularia.
Moonstone.
Sunstone.
Rhyacolite.
Valencianite.
Amanzite.
Microcline.
Murchisonite.
Necronite.
Weissigite.
Chesterlite.
Amazon Stone.
Glassy Felspar, or Sanidine.
Ice Spar.
Perthite.
Loxoclase.
Erythrite.
Variolite.

Albite, or Soda Felspar.
Pericline.

Oligoclase.
Peristerite.
Hafnefjordite.
Andesine.

Labradorite, or Labrador Felspar.
Paralogite.
Paulite.
Maulite.
Vosgite.
Silicite.

Anorthite, or Lime Felspar.
Indianite.
Amphodelite.
Biotina.
Latrobite.
Lepolite.
Thiosaurite.
Bytownite.
Polyargite.
Rosellane.
Hyalophane, or Baryta Felspar.

Danburite, or Boron Felspar.

Obsidian, or Volcanic Glass.
Pitchstone.
Cantalite.
Pearlstone.
Sphærulite.
Pumice.
Krablite.
Baulite.
(*End of Felspar section.*)

Anhydrous Silicates of Alumina, Lime, &c.

GARNET SECTION.

Iron Garnet.

Common Garnet.*
Almandine, or Precious Garnet.
Pyrope, or Fire Garnet.
Carbuncle.
Allochroite.

Lime Garnet.

Grossular.
Cinnamon Stone, or Essonite.
Wiluite.
Romanzoffite.
Topazolite.
Succinite.

Iron-lime Garnet.

Melanite, or Black Garnet.
Pyreneite.
Aplome.
Colophonite.

Manganese Garnet.

Spessartine.
Polyadelphite.

Lime-chrome Garnet.

Uwarowite.
(*End of Garnet section.*)

Meionite.
Sarcolite.
Scapolite, or Wernerite.

Glaucolite.
Nuttalite.

Algerite.
Palagonite.
Paranthine.
Esmarkite (Dufrénoy).
Jadéite, or Green Jade.
Prehnite.
Edelite.
Pufflerite.
Koupholite.
Porcellanite, or Porcelain Spar.
Unionite, or White-lime Epidote.
Zoisite.
Dipyre.

Hydrous Silicates of Alumina, Potash, Soda, &c.

Pollux.
Damourite.
Herschellite.

ZEOLITE SECTION.

Analcime.
Eudnophite.
Glottalite.
Cluthalite.
Doranite.
Natrolite, or Soda Mesotype.
Bergmannite.
Lehuntite.
Radiolite.
Savite.
Galactite.
Iron Natrolite.

Silicates of Alumina, Lime, &c.

Okenite.
Dysclasite.
Ædelforsite.
Scolesite, Needlestone, or Lime Mesotype.
Stellite.
Poonahlite.
Scolexerose.
Mesolite.
Antrimolite.
Fargite.
Harringtonite.
Mesole.
Brevicite.
Bergmannite.
Thomsonite.
Picrothomsonite.
Chalilite.
Scoulerite.
Ozarkite.
Carphostilbite.
Stilbite, or Radiated Zeolite.
Hypostilbite.
Sphærostilbite.
Heulandite, or Foliated Zeolite.
Beaumontite.
Laumontite, or Efflorescing Zeolite.
Caporcianite.
Retzite.
Ittnerite.

Leonhardite.
Faujasite.
Phillipsite, or Lime Harmotome.
Gismondine, or Zeagonite.
Pectolite.
  Soda Table-spar.
  Ratholite.
  Stellite.
Apophyllite, or Pyramidal Zeolite.
  Tesselite.
  Albin.
  Oxhaverite.
Chabazite.
  Acadialite.
  Haydenite.
  Phacolite.
Gmelinite, or Soda Chabazite.
Ledererite.
Levyne.

Silicates of Alumina, Baryta, &c.

Harmotome, or Cross-stone.
  Morvenite.
Brewsterite.
Edingtonite.

Silicates of Alumina, Lime, and Magnesia.

Sloanite.
Portite.

Pyrallolite.

Silicates of Alumina, Lime, &c.

Ellagite.
Beaumontite.
Neurolite.
Thulite.
Margarite.
Diphanite.
Uigite.
Euphyllite.

Silicates of Alumina, Lime, and Iron.

Anhydrous.

Isopyre.
  Tachylite.
Cyclopite.

Hydrous.

Plinthite.
Melanolite.

Hydrous Silicates of Alumina and Magnesia.

Soapstone or Saponite.
  Piotine.
  Thalite.

Pyrosclerite.
  Loganite.
  Chonikrite.
  Vermiculite.

Anauxite.

Anhydrous Silicates of Alumina and Iron.

Almandine, or Precious Garnet.
Allochroite.
Common Garnet.

Silicates of Alumina, Lime, Iron, Cerium, &c.

Anhydrous.

Cerium Epidote.
Allanite.
  Orthite.

Hydrous.

Thulite.

Anhydrous Silicates of Alumina, Lime, and Chrome.

Uwarowite.
Pyrope, or Fire Garnet.
  Carbuncle.

Silicates of Alumina, Lime, Magnesia, and Alkalies.

Anhydrous.

Couzeranite.

Hydrous.

Wilsonite.
Gieseckite.
Pipestone.

Silicates of Alumina, Magnesia, and Iron.

Anhydrous.

Magnesia-Garnet.
Iolite, or Dichroite.
  Aspasiolite.
  Bonsdorffite.
  Peliom.
  Steinheilite.
  Fahlunite.
  Hard Fahlunite.
  Gigantolite.
  Liebenerite.
  Pinite.
  Praseolite.
  Esmarkite (Erdmann)
  Pyrargillite.

Hydrous.

Chlorite.
  Pennine.
  Clinochlore.
  Ripidolite.
  Rhodochrome.
  Rhodophyllite.
    Pyrosclerite var.
  Kämmererite.
    Grastite var.
  Tabergite.
  Lophoite.
  Ogcoïte.
  Aphrosiderite.
  Leuchtenbergite.

Green Earth.
Epichlorite.

Schiller Spar.
Pimelite.
Polychroilite.
Chloritoid
  Masonite.

Silicates of Alumina, Lime, Magnesia, and Iron.

Anhydrous.

Gehlenite.
Glauconite.
Idocrase.
  Egeran.
  Frugardite.
  Jeffreinowite.
  Protherite.
  Xanthite.

Hydrous.

Teratolite.
Delessite.
  Grengesite.
Baralite.

Silicates of Alumina, Lime, Magnesia, Iron, and Alkalies.

Anhydrous.

Mellilite.
  Somervillite.
  Zurlite.
  Humboldtilite.
Wichtisite.
  Sordawalite.

MICA SECTION.

Biaxial or Potash Mica.
Muscovite, or Muscovy Glass.
  Margarodite.
  Adamsite.
  Gilbertite.
  Damourite,
  Paragonite.

Biotite, or Uniaxial Mica.
  Meroxene.
  Rubellane.
  Voigtite.
  Lepidomelane.
  Astrophyllite.

Phlogopite (Rhombic Mica).

Fuchsite (Chromium Mica).

Lepidolite, or Lithia Mica.
(End of Mica section.)

Hydrous.

Clintonite.
  Disterrite.
  Brandisite.
  Seybertite.
  Xanthophyllite.
Palagonite, or Hydrous Scapolite.
  Notite.
Skolopsite.
Green Earth.
  Kirwanite.

Anhydrous Silicates of Alumina, Lime, and Yttria.

Pistacite, or Lime-and-Iron Epidote.
  Arendalite.
  Bucklandite.
  Puschkinite.
  Achmatite.
  Thallite.
  Rosstrevorite.
Zygadite.

Anhydrous Silicates of Alumina, Potash, Lithia, &c.

Lithia Mica, or Lepidolite.
Zinnwaldite.
Weissigite.

Anhydrous Silicate of Alumina and Manganese.

Spessartine, or Manganese Garnet.

Hydrous Silicate of Alumina, Manganese, and Iron.

Carpholite.

Anhydrous Silicates of Alumina, &c. with Boracic Acid.

Tourmaline.
Rubellite.

Schorl.
Zeuxite.

Anhydrous Silicates of Alu- &c. with Boracic

Anhydrous Silicate of Alumina, Titanic Acid, Yttria, Lime, &c.

Keilhauite.

Hydrous Silicate of Alumina, Chromium, &c.

Chrome Ochre.

Anhydrous Silicate of Alumina, Magnesia, and Alkalis.

Pegmatolite.

Anhydrous Silicates of Alumina and Lithia.

Spodumene.
Killinite.
Castor.

Anhydrous Silicate of Alumina, Lithia, and Soda.

Petalite.

Anhydrous Silicates of Alumina and Glucina.

Emerald.
Beryl.
Aquamarine.

Davidsonite.
Goshenite.

Anhydrous Silicate of Glucina and Lime.

Leucophane.

Silicates of Zirconia.

Anhydrous.

Zircon.
Jargoon.
Jacynth, or Hyacinth.
Zirconite.
Ostranite.
Erdmannite.
Malacone.
Tachyaphaltite.
Calyptolite.
Auerbachite.

Hydrous.

Catapleiite.

Hydrous Silicate of Thoria.

Thorite.
Monazite.
Pyrochlore.

Hydrous Silicate of Cerium, Lanthanum, Didymium, &c.

Mosandrite.

METALLIC MINERALS.

CLASS I.

BRITTLE AND DIFFICULTLY FUSIBLE.

TITANIUM.

Rutile.
Sagenite.
Anatase.
Brookite.
Nigrine.
Gallicinite.
Iserine.
Ilmenite.
Hystatite.
Washingtonite.
Crichtonite.
Ilmenorutile.
Menaccanite.
Mohsite.

Warwickite.

Perowskite.
Polymignite.
Polycrase.
Æschynite.

Sphene.
Greenovite.
Guarinite.
Lederite.
Séméline.
Spinthère.
Ligurite.

Keilhauite.

Oerstedite.
Mosandrite.
Tschewkinite.

TANTALUM.

Fergusonite.
Tyrite.
Tantalite.
Cassiterotantalite.
Ixiolite.
Dianite.
Yttrotantalite.
Euxenite.
Pyrochlore.
Microlite.

NIOBIUM.

Samarskite.
Adelpholite.

TUNGSTEN.

Wolframine.
Scheelite.
Wolfram.
Scheelitine

MOLYBDENUM.

Molybdine.
Molybdenite.

VANADIUM

Vanadinite.
Volborthite.
Eusynchite.

CHROMIUM.

Oxide of Chrome, or Chrome Ochre.
Chrome-stone.
Wolchonskite.
Uwarowite, or Chrome Garnet.
Chromite, or Chromic Iron.

URANIUM.

Uranochre, or Zippeite.
Pitchblende.
Coracite.
Pittinerz.
Gummierz.
Uranoniobite.

Eliasite.

Liebigite.
Urankalk-carbonat.
Voglite.

Johannite.
Medjidite.
Uranite.
Autunite, or Yellow Uranite.
Chalcolite.
Urangreen.

MANGANESE.

Psilomelane.
Varvicite.
Wad.
Pyrolusite.
Polianite.

Manganite.
Braunite.
  Marceline.
Hausmannite.
  Rancierite.

Diallogite.
  Wiserite.
Manganocalcite.
Rhodonite, or Manganese Spar.
  Allagite.
  Bustamite.
  Fowlerite.
  Dysluite.
  Opsimose.
  Paisbergite.
  Stratopeite.
Photizite.
  Troostite.
Tephroite, or Manganesian Chrysolite.
  Knebelite.
Helvine.
Carpholite.
Manganese Blende.
Hauerite.

Manganesian Alum.

Triplite.
Hureaulite.

Kaneite.

Greenovite.

Crednerite.
Pelokonite.
Lampadite.

CLASS II.

Brittle, easily Fusible, and Volatile.

Native Arsenic.

Arsenolite.

Orpiment.
Realgar.
Dimorphine.
Arsenical Pyrites, or Leucopyrite.

Allemontite.

Skutterudite.

Gersdorffite.

Native Antimony.

Senarmontite.
Valentinite.
Antimonphyllite.
Antimonial Ochre.

Stibiconise.
Cervantite.
Volgerite.

Kermesite, or Red Antimony.

Stibnite.

Zinkenite.
Jamesonite.
Plagionite.

Arsenical Antimony.

Ullmannite.

TELLURIUM.

Native Tellurium.

Tellurite, or Telluric Ochre.

Hessite.
  Petzite.
Sylvanite (Müllerine), or Yellow Tellurium.
Graphic Tellurium.
  Aurotellurite.
Nagyagite, or Black Tellurium.

BISMUTH.

Native Bismuth.

Bismuth Ochre.
Agnesite.
Bismutite.

Eulytine, or Bismuth Blende.

Karelinite.

Bismuthine.
Wittichite, or Cupreous Bismuth.
  Tannenite.
Aikenite, or Needle-ore.

Tetradymite, or Telluric Bismuth.

CLASS III.

Malleable, not reducible by Heat alone.

ALUMINUM.

Cryolite.
Pachnolite.

ZINC.

Zincite, or Red Oxide of Zinc.

Calamine, or Zinc Spar.
Zinc Bloom.
Herrerite.
Aurichalcite. }
Buratite. }

Zinc-Iron Spar.
Kapnite.

Smithsonite, or Zinc Glance.
Willemite.
  Troostite (*Shepard*).
Automolite.
Wagite.

Hopeite.

Voltzite.
Blende, or Zinc Pyrites.
  Cleiophane.
  Marmatite.
  Wurtzite.
Goslarite, or Sulphate of Zinc.
Almagrerite.

CADMIUM.

Greenockite.

Przibramite (*Huot*) or Cadmiferous Blende Przibram.

TIN.

Cassiterite, or Tin Stone.
  Sparable Tin.
  Stream Tin. }
  Toad's-eye Tin. }
  Rosin Tin.

Tin Pyrites.

LEAD.

Native Lead.

Plumbic Ochre.
Minium, or Red Lead-ore.
Plattnerite.

Cerusite, or White Lead-ore.

Galena.
  Blue Lead.
  Johnstonite.
  Steinmannite.
  Targionite.
Argentiferous Galena.

Anglesite.

Lanarkite.
  Leadhillite.
  Susannite.

Cotunnite.
Matlockite.
Mendipite.

Cromfordite, or Horn Lead.

Pyromorphite.
  Polysphærite.
  Miesite.
  Nussierite.

Clausthalite.
  Raphanosmite.
Tilkerodite.

Plumbocalcite.

Scheeletine.

Wulfenite, or Yellow Lead-ore.

Vanadinite.

Descloizite.

Dechenite.
Crocoisite.
Melanochroite.

Mimetite, or Green Lead-ore.
Hedyphane.
Kampylite.
Dufrenoysite.

Bleinierite.
Moffrasite.

Kilbrickenite.
Geocronite.
Schulzite.
Boulangerite.
Heteromorphite, or Feather-ore.
Meneghinite.
Jamesonite.
Plagionite.
Zinkenite.

Altaite.

Kobellite.

Bournonite.
Percylite.
Caledonite.
Linarite.
Cuproplumbite.
Wölchite.
Vauquelinite.

ON.

Native Iron.
Meteoric Iron.

Magnetite.
Iron Earth.
Martite.

Goethite.
Lepidokrokite.
Onegite.
Przibramite.
Rubinglimmer.
Sammetblende.
Stilpnosiderite.
Pyrosiderite.

Limonite or Brown Iron-ore.
Brown Hæmatite.
Wood Hæmatite.
Quellerz.
Bean-ore or Bohn-erz.
Pea Iron-ore.
Xanthosiderite.
Bog Iron-ore.
Lake-ore.
Brown Ochre, or Ochry-brown Iron-ore.
Yellow Ochre.

Umber.
Terra di Sienna.

Hæmatite, or Red Iron-ore.
Specular Iron-ore.
Micaceous Iron-ore.
Red Hæmatite, or Fibrous Red Iron-ore.
Red Ochre.
Reddle.
Red Chalk.
Scaly Red Iron-ore.
Red Iron Froth.
Turgite?

Chalybite, or Sparry Iron-ore.
Sphærosiderite.
Oligon Spar.
Junckerite.
Clay Iron-stone.
Black Band.
Septaria.

Vivianite.
Mullicite.
Anglarite.
Blue Iron-earth.
Dufrénite.
Calciferrite.
Delvauxene.
Beraunite.
Carphosiderite.
Zwieselite.
Triplite.
Hureaulite.
Triphyline.
Heteposite.
Tetraphyline.
Alluaudite.

Pyrrhotine, or Magnetic Pyrites.
Pyrites.
Marcasite, or White Iron Pyrites.
Radiated Pyrites.
Spear Pyrites.
Cockscomb Pyrites.
Hepatic Pyrites.
Wasserkies.
Kyrosite.
Cellular Pyrites.
Copperas, or Sulphate of Iron.
Carphosiderite.
Copiapite.
Coquimbite.
Blakeite.
Halotrichite.
Halotrichine.
Jarosite.
Botryogene.
Voltaite.
Misy.
Diadochite.

Zeilanite.

Sideroschisolite.
Hyalosiderite.
Chlorophæite.
Fayalite.
Pyrosmalite.
Hisingerite.
Thraulite.
Gillingite.

Nontronite.
Halloysite of St. Jean de Cole.
Chamoisite.
Stilpnomelane.
Lievrite.
Wehrlite.
Cronstedtite.
Pinguite.
Gramenite.
Chloropal.

Iron Apatite.

Mispickel, or Arsenical Iron-ore.
Danaite.
Plinian.
Glaucodote.
Leucopyrite.
Satersbergite.
Symplesite.
Pharmacosiderite, or Cube-ore.
Scorodite.
Pitticite, or Pitchy Iron-ore.
Arsenosiderite.

Franklinite.

COBALT.

Asbolan, or Earthy Cobalt.

Remingtonite.

Syepoorite.
Linnæite, or Cobalt Pyrites.
Carrollite.

Cobaltine, or Cobalt Glance.
Smaltine, or Tin-white Cobalt.
Safflorite.

Erythrine, or Cobalt Bloom.
Köttigite.
Cobalt Coating.
Roselite.

Biebrite, or Cobalt Vitriol.

NICKEL.

Annabergite.

Emerald Nickel.
Zaratite.
Millerite, or Capillary Pyrites.
Placodine.

Breithauptite, or Antimonial Nickel.
Cloanthite, or Arsenical Nickel.
Rammelsbergite, or White Nickel-Pyrites.
Gersdorffite, or Nickel Glance.

Tombasite.
Amoibite.
Corynite.
Ullmannite.
Copper Nickel.

Nickel Ochre.

Meteoric Iron, or Meteorites.
Meteoric Minerals, viz.:
Apatoid.

Chladnite.
Dyslytite.
Iodilite.
Howardite.
Olivenoid.
Partschite.
Schreibersite, or Shepardite.
Sphenomite.
Iron-nickel Pyrites, or Eisennickelkies.
Pentlandite.

Pimelite.

Pyromeline, or Nickel Vitriol.

COPPER.

Native Copper.

Tenorite.
Cuprite, or Red Copper-ore.
Chalcotrichite.
Tile-ore, or Ziegelerz.
Melaconite, or Black Copper-ore.

Mysorine.
Malachite, or Green Copper-ore.
Chessylite, or Blue Copper-ore.

Phosphorocalcite.
Ehlite.
Libethenite.
Thrombolite.
Tagilite.

Copper Glance.
Nail-headed Copper-ore.
Harrisite.
Covelline.
Erubescite, or Bornite (Purple Copper-ore).
Chalcopyrite, or Copper Pyrites.
Peacock Copper-ore.
Blistered Copper-ore.
Barnhardtite.
Tetrahedrite, Fahlerz, or Grey Copper-ore.
Annivite.
Polytelite. }
Freibergite. }
Fournelite.
Spaniolite. }
Schwarzerz. }
Wolfsbergite.
Bournonite.

Brochantite.
Königite.
Krisuvite.
Langite.
Devilline.
Cyanosite.
Lettsomite.
Vitriolite.

Atacamite.

Dioptase, or Emerald Copper.
Chrysocolla.
Kupferpecherz.
Taltalite.
Chalkolite.
Crednerite.
Algodonite.
Domeykite.
Cornwallite.
Condurrite.
Erinite.
Clinoclase.
Tyrolite.
Olivenite.
Wood Arseniate.
Euchroïte.
Liroconite.
Chalcophyllite.
Lindackerite.
Whitneyite.
Darwinite.

Alisonite.

Berzelianite.
Selenkupferblei.
Selenbleikupfer.
Vauquelinite.

CLASS IV.

NOBLE METALS.

Reducible by Heat alone.

MERCURY.

Native Quicksilver.

Native Amalgam.

Cinnabar.

Hepatic Cinnabar.

Calomel, or Horn Mercury.

Coccinite.

Ammiolite.

SILVER.

Native Silver.

Selbite.
Kerargyrite, or Horn Silver-ore.
Butter-milk Silver-ore.

Silver Glance.
Silver Black.
Deleminzite.
Jalpaite, or Cupriferous Silver Glance.
Stromeyerite, or Cupriferous Silver Glance.
Discrasite, or Antimonial Silver-ore.
Stephanite, or Brittle Silver-ore.
Polybasite.
Psaturose.
Fireblende.
Sternbergite.
Flexible Sulphide of Silver.
Freieslebenite.

Red Silver-ore.
Pyrargyrite, or Dark Red Silver-ore.
Proustite, or Light Red Silver-ore.

Xanthocone.
Miargyrite.

Bismuthic Silver-ore.

Naumannite, or Selenide of Silver.
Riolite.
Eucairite.

Hessite, or Telluric Silver-ore.

Bromyrite, or Bromic Silver-ore.

Embolite.
Megabromite.
Mikrobromite.

Iodyrite, or Iodic Silver-ore.

GOLD.

Native Gold.

Electrum.

Gold Amalgam.

Auriferous Pyrites.

Aurotellurite.

PLATINUM.

Native Platinum.
Platin-iridium.

PALLADIUM.

Native Palladium.

Porpezite, or Oro Pudre.

RHODIUM.

Rhodium Gold.

IRIDIUM.

Native Iridium.

Iridosmine, or Native Alloy.

Irite.

OSMIUM.

Irid-osmine.

Irite.

LANTHANUM.

Lanthanite.

Lanthanum, Cerium, and Didymium.

Parisite.

Lanthanum, Cerium, Didymium, and Titanic Acid.

Tschewkinite.

COLUMBIUM.

Microlite.
Torrelite.
Pyrorthite.
Tyrite.
Bragite.

Columbic and Titanic Acid, and Lanthanum.

Pyrochlore.

CERIUM.

Cererite, or Cerite.
Lanthanocerite.

Allanite.
Orthite.
Uralorthite.
Xanthorthite.
Bodenite.
Cerine.
Bagrationite.
Muromontite.
Tritomite.

Cryptolite.
Phospho-cerite.
Monazite.
Edwardsite.

Yttro-cerite.

Fluocerine.
Fluocerite.

Some of the names in the preceding list have been purposely inserted twice. By that means, certain groups (as the Garnets, Felspars, Zeolites, &c.) can be either kept together, or the minerals which compose them can be inserted in the places which they would more properly occupy, if arranged strictly according to the chemical composition of each particular member.

The names printed in a smaller type are those of varieties of the mineral which they immediately follow.

Minerva. This name of the Latin goddess who was identified with the Greek Athênê is, in the opinion of Professor Max Müller, clearly connected with *mens*, the Greek *μένος*, and the Sanscrit manas, *mind*, thus expressing a purely intellectual idea; while that of Athênê denotes the physical character of the dawn-goddess, who springs from the forehead of Zeus, *the sky*. It is not, however, difficult to trace the connection of the two ideas. The kindred Sanscrit roots *ah* and *dah* which furnished names for Ahana and Dahana (Daphne), *the dawn*, supplied also the germ of Athênê; and the notion of the being who wakes up the world after the darkness of night soon passed into that of wisdom, the metaphorical connection of light and knowledge (the *φῶς* and *γνῶσις* of the fourth Gospel) being of the closest kind. Thus in one of the Vedic hymns it is said of the dawn that 'waking every mortal to walk about, she received praise from every *thinker*.' It must likewise be remembered that the Latin name Minerva is explained by *mane*, the morning, by *manare*, a verb specially applied to the rising sun, and by Matuta, *the dawn*. But while the general characteristics of the goddess are for the most part faithfully preserved, the myths which have clustered round these names vary greatly in form and incident. Thus the Vedas mention no mother of the dawn, and the Homeric poems know of no mother of Athênê, whom they represent throughout as a virgin goddess. As springing from the forehead of Zeus, Dyu, *the east*, she was called at Rome Capta, i.e. Capita (from caput, *the head*); in Messene, Koryphasia (*κορυφή*, *the head*); in Argos, Akria (*ἄκρος*, *topmost*). (Max Müller, *Lectures on Language*, second series, pp. 503 et seq.) But there were legends which made Apollo the son of Athênê, and these are at once explained if we regard him as the sun-god rising from the brightness of the dawn, while as following the night he was the son of Leto (a name which reappears in the words Latona, Lethe, lethum, all denoting forgetfulness and death). In the *Iliad* and *Odyssey*, Athênê is intimately associated with the solar heroes Achilles and Odysseus; it is she who restores the latter to his pristine beauty, and imparts vigour to the failing limbs of Laertes. In general she is represented in these poems as being in perfect accord with the will of Zeus; but in one passage of the *Iliad* (i. 400) she engages in an abortive conspiracy to bind Zeus, in which she is the accomplice of Hera and Poseidon. In the legend of Pandora, at the instigation of Zeus she takes part in the plot which results in the increased wickedness and misery of man; while in contrast with this the myth of Prometheus exhibits her as aiding in his theft of fire against the will of Zeus, and one version represents her as so acting, not from feelings of friendship, but from the passion of love. Her epithet *τριτογένεια* is explained by M. Bréal (*Hercule et Cacus*, p. 17) by a reference to the Vedic Trita, who reigns over the waters and the air, and whose name reappears in the Greek Triton and Amphitrite.

At Rome, Minerva had three temples: one on the Capitol; a second on the Aventine; and a third on the Cælian Mount. There were also two great festivals celebrated annually in her honour; the one called QUINQUATRUS or QUINQUATRIA, the other QUINQUATRIA MINORA [which see]. The personification of thought or judgment in the Latin Minerva is shown in many proverbial phrases, as *Sus*

(the fool instructs the wise); to do a thing, *tenui, pingui*, or *crassâ Minervâ*, is to do it poorly, stupidly, or awkwardly.

Miniature (Fr. from miniare, *to colour with minium*, first applied to the decoration of MSS., and signifying the large initial letters written in minium or red lead). In Painting, a representation of nature on a very small scale. *Miniature painting* is generally executed on ivory; and is, as to composition, drawing, and finishing, subject to the same laws as painting. The outline is traced upon the ivory with a silver point or pencil, and must be extremely light and delicate. This is afterwards drawn in with thin carmine as correctly as possible; the corrections being made with finely powdered pumice-stone, rubbed on with a paper or leather stump. The dead colouring then proceeds, wherein the shadows are left delicate and the lights strong, the full effect being afterwards produced by dotting. The artist usually begins the shades with vermilion and carmine, giving the strongest touches to the most prominent parts, and to the parts where separations are marked out in shades that are obscure. Indigo is afterwards used for the bluish shades on such parts as recede from the light. Yellow tints, composed of ochre and vermilion, are usually employed on the sides of the nose towards the bottom, under the eyebrows, underneath the cheeks, and on other parts rising towards the light. The backgrounds, if dark, are commonly composed of bistre, umber, or Cologne earth, with black and white; others of a yellow cast by the use of ochre. The grey backgrounds are formed by black, white, and a little indigo. When of a green or olive hue, Dutch pink, white, and black are the ingredients. The backgrounds are formed in two coats, first laying on a light thin tint, and afterwards a darker one of the same colour, evenly and smooth. The dotting is performed by separate dots, or by short hatching strokes crossing each other every way so as to have the appearance of being dotted.

Among miniature painters, the most distinguished are: Attavante; Memling (died 1495); Giulio Clovio; Nicholas Hilliard; Isaac Oliver and Peter Oliver; Samuel Cooper (1609–72); Jacques Antoine Arlaud (1668–1743); Rosalba Carriera; and Jean Étienne Liotard, who died in 1776: the present century has also had many distinguished artists of this class, but the art of miniature painting as applied to portraiture has greatly suffered of late years through the introduction of photography.

Minim (Lat. minimus). In Music, a character equal in duration to two crotchets, or half a semibreve.

Minim. The sixtieth part of a fluid drachm.

Minims or Minimi, Order of the. A religious order instituted by St. Francis de Paulo in the fifteenth century. By the name, derived from Lat. minimus, *the least*, the founder meant to indicate that humility should be the distinguishing feature of the order. In conformity with this design the rules he prescribed were of the strictest kind. Besides the three usual vows of poverty, continence, and obedience, the most rigid abstinence was inculcated. Except in cases of illness, the members were prohibited not only from touching animal food, but even butter, milk, or cheese, or indeed any kind of sustenance in the composition of which such materials were used. Their dress was of the coarsest kind; the colour being black, like that of the Franciscans. Long before the death of its founder, this order had attained so high a degree of celebrity for sanctity that it could boast of monasteries in Italy, France, Spain, and Germany; and at no very distant period it counted no fewer than 450 religious houses scattered throughout Europe and Asia.

Minimum. [Maxima and Minima.]

Minimum Squares. In the theory of observations the *method of minimum squares* is that by means of which the most correct result is sought to be deduced from a series of mutually discordant, but equally trustworthy, observations. The principles upon which the method is founded are somewhat obscure, and differ in different writers, all of whom, however, agree in their conclusions. The reader will find these principles ably discussed in a memoir by Ellis in the eighth volume of the *Cambridge Transactions*, 1844. We must here confine ourselves to the briefest possible illustration of the method, and refer the reader for principles and details to the collected works of Gauss and Laplace, the founders of the method, or to one or other of their commentators; amongst whom may be mentioned: Poisson (*Connaissance des Temps*, 1827); Ellis; Ivory in *Tilloch's Magazine* and *Philosophical Magazine*; Airy in his *Theory of Errors of Observation*, &c. London 1861; and the 'Essays on Probabilities' in the *Cabinet Cyclopædia* 1838, *Encyclopædia Metropolitana*, and *Penny Cyclopædia*. Gauss' researches on the subject have been collected and translated by Bertrand under the title *Méthode des Moindres Carrés*, Paris 1855—a useful little work.

To illustrate the method by an example, let us suppose our object to be the determination of the most probable values of a series of n magnitudes, $x_1, x_2, \ldots x_n$, which satisfy a certain equation of condition

$$a_1 x_1 + a_2 x_2 + \ldots a_n x_n - V = 0;$$

of which the coefficients $a_1, a_2 \ldots V$, however, can only be determined by observations liable to error. By a series of m equally trustworthy observations (m usually exceeds n), we shall be led to the following system of equations:—

$$\begin{array}{l} a_{1,1} x_1 + a_{1,2} x_2 + \ldots a_{1,n} x_n - V_1 = e_1 \\ a_{2,1} x_1 + a_{2,2} x_2 + \ldots a_{2,n} x_n - V_2 = e_2 \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ a_{m,1} x_1 + a_{m,2} x_2 + \ldots a_{m,n} x_n - V_m = e_m, \end{array}$$

where $e_1, e_2 \ldots e_m$ are unknown quantities which would severally vanish if the observa-

tions were all accurate. This not being the case, they represent the *errors of the observations.* Now by the law of minimum squares *the most trustworthy values* of $x_1, x_2 \ldots x_n$, *under the given circumstances, are those which render the sum of the squares of the errors*, viz. $e_1^2 + e_2^2 + \qquad + e_m^2 = s$, a MINIMUM. According to the principles of the differential calculus, therefore, the n equations, which precisely suffice for the determination of $x_1, x_2 \ldots x_n$, are—

$$\tfrac{1}{2}\frac{ds}{dx_1} = a_{1,1}\,e_1 + a_{2,1}\,e_2 + \qquad .\ a_{m,1}\,e_m = 0$$

$$\tfrac{1}{2}\frac{ds}{dx_2} = a_{1,2}\,e_1 + a_{2,2}\,e_2 + \qquad .\ a_{m,2}\,e_m = 0$$

$$\tfrac{1}{2}\frac{ds}{dx_n} = a_{1,n}\,e_1 + a_{2,n}\,e_2 + \qquad .\ a_{m,n}\,e_m = 0.$$

The solution of these equations, after substituting for e_1, e_2 &c. their values in x_1, x_2 &c., is effected in the ordinary manner. Instead of here exhibiting the general formulæ, we prefer to consider the special case where there is but one magnitude $x_1 = V$ to be determined directly from observation. We have here, of course, $a_{i,j} = 0$ for all values of j different from 1, and $a_{i,1} = 1$ for all values of i. All the above equations vanish except the first, which reduces to $mx_1 = V_1 + V_2 + \ldots V_m$, and gives us the ordinary *average* or arithmetic mean of all the observations, as the best value of x_1. Suppose next we had to determine the most probable value of a certain quotient $x_1 = \frac{V}{a_1}$ from m observations which gave the dividends $V_1, V_2 \ldots V_m$, and the corresponding divisors $a_{1,1}, a_{2,1}, \ldots a_{m,1}$. We should have, from the first, and sole equation,

$$x_1 = \frac{a_{1,1}\,V_1 + a_{2,1}\,V_2 + \ \ldots\ a_{m,1}\,V_m}{a_{1,1}^2 + a_{2,1}^2 + \ \ldots\ a_{m,1}^2},$$

as the most trustworthy value of the unknown quotient $\frac{V}{a_1}$. The quotient obtained by dividing the mean of the observed dividends V by the mean of the observed divisors a_1, that is to say the quotient

$$\frac{V_1 + V_2 \qquad V_m}{a_{1,1} + a_{2,1} \ \ldots\ a_{m,1}}$$

would in general differ from the above and be less trustworthy.

Mining. The operation of discovering and removing from the bowels of the earth such minerals as are valuable to man. When the minerals in question occur at the earth's surface, so that they can be removed by the light of day, the operation is properly regarded as QUARRYING [which see]. The nature of the materials removed should make no difference in the term, as many earthy minerals are mined for, and many mineral veins quarried.

The first operation of mining is the discovery of mineral, and this depends partly on the geological position of the mineral sought for. If a bed or stratum is required to be extracted, and this bed is nearly horizontal, it will crop out along a line, and levels or tunnels driven in at any part of this line or outcrop will lead to a knowledge of the state of the deposit, and suggest means of working it. If a mineral vein is the object, the outcrop is less distinct, and often at the surface the discovery indicates very slightly the nature and magnitude of the deposit. These two great methods of mining are illustrated in England, one by coal mining, and the other by copper and lead mining.

In coal mining, the object is to remove as much as possible of a distinct bed or deposit of mineral, forming an integral part of the earth at the spot where it occurs. It is clear that if this be removed, the earth above must come down, the mineral having been entirely under the pressure of the superincumbent mass, which increases with the depth of extraction. Provision must, therefore, be made against the falling in of the roof during the progress of extraction. It is also clear, that since much water exists in the earth, and moves with a certain freedom through strata, we may chance to cut strata that will, if passed through, let down much water to the work below, even if in the works themselves there is not a natural and great accumulation of water. Under any circumstances, extensive works carried on at any considerable depth below the surface will certainly need support and probably drainage.

Lastly, it will not be difficult to understand that a free circulation of air is necessary for carrying on the works, more especially when they are deep and extensive. Thus the system of mining must have reference to the nature of the roof and the depth of the mine, to the drainage of the mine, and to the ventilation. In order to reach the mineral, it is generally necessary to sink a pit or shaft, an operation the expense and difficulty of which depend on local circumstances.

In mining for ores that exist in mineral veins, there is often little difficulty in regard to the roof, as the ore fills up a gap which has no tendency to close, and, shafts being frequent for the sake of getting the ore, there is seldom much trouble with ventilation. Drainage in such cases is, however, generally of primary importance.

The mining operations, when access is once obtained to a deposit of valuable mineral, must be regulated by the hardness, toughness, and condition of the mineral. Coal can be removed by undermining or underholing, that is by cutting a deep groove at the bottom of the bed, and using wedges to make it fall. Ores are generally obtained by blasting, or by *pick and gad*—the pick and small iron wedges called gads being the common tools of the miner. Once obtained, the produce has to be carried along to the shaft, and then lifted to the surface—operations less simple than they at first appear, but not requiring special notice in this place.

The drainage of mines is effected generally

by a mixed system, the water being carried off as far as possible by natural drains to as low a level as circumstances admit [ADIT], and the rest pumped by powerful machinery or lifted in iron buckets, according to the quantity and magnitude of the works. Steam is largely employed in draining, and the same lifting power is made use of to remove the mineral to the surface.

Ventilation is carried on in coal mines by a system of subdivision of the work, and by placing walls and doors to insure a current of air throughout. The air is generally drawn into the mine at one shaft, by converting another into a chimney and placing a furnace at the bottom to insure a draught.

The roof of a coal mine always requires careful attention. At first only so much coal is taken as to leave sufficient support. The roof of the galleries thus made is propped, and the rest of the coal is then removed carefully. Ultimately the roof is allowed to fall.

In metal mines a number of shafts are sunk, generally in or near the lode, or through rocks to cut it. The shafts are much more numerous than in coal mines, and often pay for their cost. The ore is removed in successive levels, beginning from below wherever it is found. The walls are left.

Minion. In Printing, the name of a kind of type, one size smaller than that used in this work. [TYPE.]

Minister (Lat.). In Politics, a servant of the sovereign executive power in a state: generally speaking, the head of a department or branch of government. Usage, in different countries, fixes very differently the limits of that higher class of servants to which the term is applied. In the British Empire, none but the heads of administrative departments are termed ministers: part of whom belong to the cabinet, and part are not included in it. The cabinet ministers have varied under different administrations; and as our government is of mixed organisation, partly to serve the actual necessities of state, and partly retaining ancient distinctions of office founded on usage only, some of the ministers hold merely sinecure appointments. In France, where the forms of government are established more on the principle of utility, there were under the Restoration eight ministers so called: 1. of the interior; 2. of finance; 3. of justice; 4. of public instruction and ecclesiastical affairs; 5. of commerce and public works; 6. of the marine and colonies; 7. of war; 8. of foreign affairs; to which the empire has added a 9th, *of the Imperial household*. In England, ministers sit and vote in either house of parliament—by hereditary right, if peers; as representatives only, if commoners. In France, ministers have also, by virtue of their office, a right to sit and take part in the debates in either chamber. In the United States, no minister (or secretary, in the language of that government) can be chosen either representative or senator. In some European countries (as Russia), a distinction is established between the private affairs of the sovereign and foreign affairs, on the one hand, which form the combined duties of the cabinet ministers; and the affairs of the interior, which are intrusted to ministers of state. There are also in some governments honorary or *conference* ministers, without any real department of duty. The representatives of minor sovereigns at foreign courts are usually styled *ministers*, instead of *ambassadors*. The term *minister* is also frequently used in a sense synonymous with *clergyman*.

Minium (Lat.). Red Lead. [LEAD.]

Minnehöfe (Ger.; literally *courts of love*). The name given by the Germans to the courts of love, famous in the history of chivalry. The subjects brought before these courts were chiefly connected with the Romantic gallantry of the period, and consisted either of questions proposed with the view to entrap the judges into some awkward decision, or of serious complaints, resulting from affairs of the heart, which were discussed with all the formality of a court of law. These minnehöfe were for a long period looked upon as forming an indispensable part in all chivalrous exercises. Knights, ladies, and poets alike participated in their proceedings; and large collections of their decisions are still extant. A certain number of ladies acted as judges in these courts, and conducted the proceedings as counsel; they were attended by a train of nobles, knights, and others, who were invested by the court with gradations of precedency analogous to those conferred by the sovereign. These courts were held periodically at Signes, Avignon, Lille, and Pierrefeu. The last regular court of this kind was celebrated by Charles VI. and his wife Isabella of Bavaria; but they were now and then renewed at irregular intervals, and the last on record took place as late as the reign of Louis XIV. We subjoin a few specimens of the questions proposed in these courts for debate and decision. 1. Which is harder to bear—the infidelity or the death of the beloved? 2. Whether does a man whose wife, or a lover whose betrothed, is unfaithful, suffer most? 3. Who is more culpable—the man who boasts of favours from a lady which he never received, or he who having really received them makes it known?

Minnesingers. The most ancient school of German poets, whose name is derived from the old German word minne (*love*). The songs and fame of the Provençal troubadours appear to have penetrated into Germany under the first emperors of the house of Hohenstauffen; in whose time the crusades and the frequent Italian wars combined to bring their nation, seated as it is in the centre of Europe, in closer communication with those surrounding it. The minnesingers imitated in German the strains of those early poets, and, like them, made love their principal subject; which was celebrated with much of pedantry and false conceits, but, at the same time, not without

generous and chivalric feeling. The verses of the minnesingers are in the old Suabian dialect of the High German, which, under the Hohenstauffens, themselves of Suabian race, was the court language. As was the case with the troubadours, the minnesingers belonged to two different classes: there were among them many knights, princes, and even sovereigns; while there was also another class of more professional poets—wandering minstrels, who attached themselves to the persons of distinguished chiefs, or wandered from court to court. The oldest of the minnesingers known to us is Henry of Veldeck, about 1170. During the remainder of the twelfth and first half of the thirteenth century this school of poets flourished; afterwards it gradually declined, and was succeeded by the less chivalrous and homelier school of the master-singers. We possess the names of more than 300 poets, and pieces of the composition of a large proportion of them, who sang during the short period in question. The German amatory poets had their high and low minne, like the celestial and popular Aphrodite of the ancients; the former an abstract and chivalric devotion to a beloved object, the latter a less elevated passion. The ancient German national epic, called the *Nibelungen Lied*, and the heroic poetry of the *Heldenbuch*, belong to the same period and dialect, and were works of the same race of poets; as were also other poetical romances, founded on the foreign traditions of France, Brittany, and classical antiquity. (*Edinburgh Review*, April 1862, p. 359; *National Review*, July 1858, p. 74.)

Minnow or **Minim** (Lat. minimus, *least*). The name of a species of Cyprinoid fish (*Leuciscus phoxinus*, Cuv.), and the smallest of the British species of that family. It inhabits many of the fresh-water streams and canals in England, and spawns in June, when each female is attended by two males.

Minor. In Music. [Major.]

Minor Determinants. [Determinants.]

Minor Term of a Categorical Syllògism. In Logic, the subject of the conclusion. The minor premiss is that which contains the minor term. In hypothetical syllogisms, the categorical premiss is called the *minor*.

Minority. In Law. [Age.]

Minority. In Politics, the period during which the sovereign in an hereditary monarchy is incapacitated from exercising the supreme authority by reason of not having attained the age prescribed by law; also the state of such incapacity. The royal authority, in hereditary monarchies, never dies; and when a sovereign deceases leaving a successor below age, it passes immediately to the person or persons whom the constitution has invested with the authority of regent; as it also does when a king becomes subject to any other incapacity. The term of royal minority is variously regulated by the constitution of different countries. The legal majority of a king of France was fixed at fourteen by an ordinance of Charles V., which has been since followed in that country; but, as a year commenced is reckoned as accomplished, the actual period at which a king of France begins to govern is the age of thirteen years and a day. The same period is fixed by the laws of Spain and Portugal. By the constitution of Great Britain the sovereign is of full age at eighteen years, as far as can be collected from the statutes passed at several times to empower the king to name a regent whenever it has been apprehended that the crown was in danger of devolving on a prince under age.

Minos. In Mythology, a son of Zeus and Europa, and king of Crete. After his death he became judge of the infernal regions, along with Æacus and Rhadamanthus. For the meaning of the name, see Menu.

Minotaur (Gr. μινώταυρος). In Mythology, a monster, half-man and half-bull, said to be the son of Pasiphäe, wife of Minos, king of Crete, by a bull (ταῦρος); hence the term Minotaur. According to one version of the myth, Minos shut him up in the labyrinth of Dædalus, feeding him with criminals, and afterwards with youths and maidens sent from Athens. Theseus, by the assistance of Ariadne, succeeded in destroying him, and thereby rescued the Athenians from the obligation of sending their children to be devoured. The bull of Minos, whose wife is Pasiphäe, the *giver of light to all*, is seen again in the bull of Indra, as well as in that which bears Europa across the sea. In some myths, as in that of the Marathonian bull, the only idea attached to it is that of devastation; but the Marathonian bull, like the Minotaur, is slain by Theseus, who is also a solar hero.

Minster (Ger. münster, Gr. μοναστήριον). In England this term was originally applied to the outposts of the Christian Church, maintained by bodies of priests living under rule in those isolated stations which have ever since that time retained the maternal title of minster. These minsters were not necessarily parish churches, although they might become the parents of many such churches. Thus every station, in the advance made by the fellow-labourers of Augustine, received the name of *monastery* or *minster*, and retained it long after the place of the monks had been filled up by secular priests. (Earle's 'Gloucester Fragments,' *Edinburgh Review*, Oct. 1862, p. 420, &c.)

Minstrels (Fr. ménestrel, from Old Ger. minne, *love*). Minstrels are defined by Percy as an order of men in the middle ages who subsisted by the arts of poetry and music, and sang to the harp verses composed by themselves or others. They appear to have been the successors of the minnesingers, scalds, and bards of different European nations, who, even after the age of chivalry had passed, attempted to gain a subsistence by practising those arts which at an earlier period had procured fame and honour for their predecessors.

In times of peace (to follow the sketch of

a writer in the *Edinburgh Review*, vol. lxxiii.) the minstrel, *omnis luxuriæ interpres*, as Pliny said of Menander, sang of mimic war to the dull barons of dungeon castles, who had ears, although they could not read—who, steeped in the weariness of wealth and want of occupation, listened greedily, like other great men, to their own praises. Minstrelsy supplied the lack of a more refined intellectual entertainment and of rational conversation, as professional gentlemen do now at civic banquets: their harpings lulled the rude Sauls to sleep, which is now done by quarto epics. The person of the minstrel was sacred; his profession was a passport; he was 'high placed in hall a welcome guest:' the assumption of his character became the disguise of lovers of adventure. These advantages raised pseudo-laureates, *idle vagabonds*, according to the Act of Edward I., 'who went about the country under the colour of minstrelsy;' men who cared more about the supper than the song; who, for base lucre, divorced the arts of writing and reciting, and stole other men's thunder. Their social degeneracy may be traced in the dictionary: the chanter of the *gests* of kings—*gesta ducum regumque*—dwindled into a *gesticulator*, a jester; the honoured jogler of Provence into the mountebank, the juggler, the *jockie*, or doggrel balladmonger.

> Beggars they are by one consent,
> And rogues by Act of Parliament.

They descended by the usual stages of things of mere fashion; at first the observed of all observers, and therefore imitated, until they became common—vulgar; a step which is at once the test of merit and universal acceptance, and the forerunner of disgrace. In Spain, particularly, this fall occurred very soon. The really good clergy were shocked at their abuses, while the interested grudged the money earned by rivals who interfered with their monopoly of instructing the people in pious [illegible] or of amusing them with alexandrine [illegible]. Their Latin synonym for *scald* [illegible]*s*—*scurra mimus*, &c.—will outlive their sculptured caricatures, in which mendicant monks, minstrels, fools, and monkeys, are pilloried on pinnacle and gurgoyle, in cloister and cathedral. The itinerant monks and mountebanks repaid all this, like Falstaff, by showing up the irregularities of regulars and seculars, 'in ballads to be sung to filthy tunes.' They undermined their influence. Preachings and songs take part in all national changes; for doctrines precede actions. They were the popular press of the time; opposed by the privileged orders, and watched by statesmen, as Burleigh afterwards employed agents to listen to street songs—the thermometer of the people's temper. In all these alterations for the worse, the primitive principle 'to entertain' remained unchanged. To this the original ballad was sacrificed; passing from one to another, each minstrel begged, borrowed, or stole from all quarters. As late as the beginning of last century the houses of many leading families, especially in the northern parts of the empire, were provided with minstrels, who were employed in various duties; all of them, however, in some degree connected with their original occupation. [BARD; SCALD; MINNESINGERS; BALLAD.]

Mint (Ger. münze, Dutch munte). The place in which the coin of the realm is manufactured. The whole of the British coin is issued from and manufactured at the Royal Mint in London. The general details of the business of the Mint are briefly stated under the article COINAGE.

The Royal Mint received its constitution of superior officers in the eighteenth year of the reign of Edward II., and continued nearly as then established to carry on its operations within the Tower of London.

Between the years 1810 and 1815 the present building was erected on Tower Hill, at the suggestion of a committee of the king's privy council, appointed in 1798 'to take into consideration the state of the coins of the kingdom, and the establishment and constitution of the Mint;' and in 1815 a new constitution was introduced, founded upon a report drawn up by Lord Maryborough, who was then master.

Under that constitution the chief officers of the Mint were the master, the deputy master, the comptroller, the king's (or queen's) assay master, the clerk of the papers, and the clerk of the irons and superintendent of machinery: these constituted *the Mint board*, and met as often as required, to transact all the general business of the establishment. The manufacture of the coin was carried on by contract under the direction of a distinct branch of the establishment known as the *Company of Moneyers*. The other officers were the master's assayer, the melter, the chief engraver, the weigher and teller, the surveyor of the meltings, and the solicitor. The duties of these officers are fully set forth in the *Mint indenture*. On the general history of the coinage, the reader is referred to Ruding's *Annals of the Coinage*, and to the article 'Coinage' in the *Encyclopædia Britannica*, which gives an account, illustrated by engravings, of the machinery employed in the Mint. A mass of valuable information, and details respecting the establishment, will also be found in the *Parliamentary Report of the Select Committee on the Royal Mint*, and its Appendix, published by order of the House of Commons, June 30, 1837. In consequence of this report, important changes were made in the mode of carrying on the business of the Mint, more especially affecting the duties and position of the master, and involving the discontinuance of the moneyers' contracts.

MINT (Lat. mentha). A name given to several herbaceous aromatic plants belonging to the natural order *Labiatæ*, and genus *Mentha*. Spearmint, or *Mentha viridis*, is that which is generally used in cookery. Peppermint, or *Mentha piperita*, yields the water and the es-

sential oil of pharmacy. Horsemint and others are also ---es of the same genus. [MENTHA.]

(Fr. menuet). A species of dance performed in slow time and with measured steps, formerly very popular, but now rarely if ever met with.

Minute (Lat. minutum, part. of minuo, *I diminish*). In the measurement of time, the sixtieth part of an hour; it is represented by the letter *m* in modern astronomical works. In the measurement of an angle, a minute, denoted by a dash or acute accent, is the sixtieth part of a degree, and consequently the 5,400th part of a right angle. It is the angle subtended at the centre of a circle by the 21,600th part of its circumference.

MINUTE. In Architecture, the sixtieth part of the diameter of a column, by which subdivision architects measure the smaller parts of an order; the diameter is chosen at the lower end of the column.

Minutes. Originally the rough draft of a public instrument drawn up by a notary; so termed because usually written in a smaller character than the instrument itself. The term is now applied to a brief report of the proceedings of a society drawn up by the clerk or secretary: in which sense it is nearly synonymous with PROTOCOL [which see].

Miocene or Middle Tertiary. The name given to a large and important division of the Tertiary series of rocks, almost absent in the British islands, but extensively developed in the east of Europe, and well shown in France and Belgium. The Faluns of the Loire are the typical Miocene beds. The Sewalik beds of the north of India are partly at least of this period. The NAGEL FLUHE and MOLASSE Swiss deposits are referred to the same age; and several large and important portions of Eastern Europe, especially in the valley of the Danube, consist of rocks of this period.

In Western Europe the Miocene deposits are not of much economic importance, but advancing eastwards, they are not only more extensive, but contain large deposits of mineral fuel, chiefly lignite. The great plains extending from the foot of the Eastern Alps to the foot of the Carpathians are lacustrine deposits of this period, rich in fossils in some localities.

Miquelets. In Modern History, partisan troops raised in the north of Spain, and chiefly in Catalonia. The Miquelets became first known in the wars between Spain and France in the seventeenth century. At several periods (in 1689, 1789, and again in the wars of Napoleon) the French have endeavoured to organise similar corps, to oppose to the Miquelets in the mountain warfare of those districts.

l. [SUPERNATURAL.]

(Fr.). An optical illusion very common at sea, especially in high latitudes, and sometimes also witnessed on land, particularly in Egypt and Persia, and on the margin of rivers and lakes, or on the seashore. It arises from the total reflection of the rays of light from the lower surface of a stratum of air. This can occur when, from any cause, such a stratum of air possesses a higher refractive power than the one immediately below it. Such a condition of the atmosphere causes remote objects to be seen as if reflected in a mirror, or to appear as if suspended in the air. When the effect is confined to apparent elevation, the English sailors call it *looming*; when inverted images are formed, the Italians give it the name of FATA MORGANA. Ships in the whale-fisheries are often descried, and sometimes known, by means of the mirage, at considerable distances. Captain Scoresby recognised his father's ship at the distance of more than thirty miles, and consequently when below the horizon, by its inverted image in the air, though he did not previously know that it was cruising in that part of the fishery. The mathematical theory of the phenomenon is given by Biot, in the *Mémoires de l'Institut* for 1809. (Caddington's *Optics*; Biot's *Traité de Physique*, tome iii.; Brewster's 'Optics,' *Cabinet Cyclopædia*.)

Mirmillones. In Roman Antiquity, a species of gladiators, who fought completely armed against the Retiarii. Their arms consisted of a sword, headpiece, and shield. On the top of the headpiece they wore a fish embossed, called *mormyr* (Gr. μορμύλος); whence the name. The Mirmillones were also termed *Galli*, from their wearing Gallic armour; and *Scutatores*, from the shield by which they were defended.

Mirror (Fr. miroir). A speculum or looking-glass, or any other polished body capable of reflecting the images of luminous or illuminated objects. Silver is the most powerful reflector, absorbing only 9 per cent. of the incident light; whilst speculum metal reflects only about 63 per cent. of the incident rays. In the very early ages of the world, polished metallic specula, especially of brass, were employed as mirrors by the Jewish and Egyptian women; but in modern times, plates of glass coated on one side with an amalgam of tin are alone used as mirrors for ordinary purposes. [MERCURY; TIN.]

Concave mirrors are sometimes used to concentrate the rays of the sun or of ignited bodies to a focus, and thereby produce intense heat. The surfaces formed by the revolution of the ellipse, parabola, and hyperbola are such that the first accurately reflects diverged rays to a focus, the second parallel rays, and the third divergent rays. The great difficulty of constructing these surfaces has led to the employment of spherical segments, which, though not accurate, yet under proper restrictions are approximately so. For the mathematical theory, see REFLECTION; see also BURNING GLASS; SPECULUM; TELESCOPE.

Mirza (a corruption of the Persian title Emir-Zadeh, *sons of the prince*). The common style of honour in Persia, when it precedes the surname; when appended to it, it signifies prince.

Mischna. The text of the Jewish Talmud, on which the *Gemara*, or second part, is a commentary. It consists of traditions and explanations of Scripture. The former are supposed by the Jews to have been delivered to Moses on the mount, and from him to have passed, through the keeping of a succession of prophets and sages, to Rabbi Juda of Tiberias, who committed them to writing. Their compilation is supposed by modern commentators to have taken place about A.C. 150 or 190. (Prideaux, *Connection*, vol. ii.; and Lardner, *Collection of Jewish and Heathen Testimonies*, vol. i.)

Misdemeanour. In Law, any offence which is the subject of indictment and punishment, not of a felonious character; such are seditious acts, perjury, battery, libels, conspiracies, attempts, and solicitations to commit felonies, &c. Over these offences the justices of the peace at quarter sessions have a general jurisdiction, although they may be removed by certiorari to the Queen's Bench; and in the trial the defendant had at least for a long period of time one remarkable privilege, viz. that his counsel might address the jury, which was equally the case in treason, but not until the year 1837 in any sort of felony. The ordinary punishment of misdemeanours is by fine and imprisonment. [Law, Criminal; Misprision; Sessions.]

Misenite. A hydrated sulphate of potash found in the form of white silky fibres in a cavern near Misene in the Campagna.

Misericordia (Lat. *pity*). A dagger, so termed in the middle ages because it was the weapon used by a knight against a dismounted adversary when he enforced him to cry for mercy. [Dagger.]

Misnomer. In Law, the description of a person by a wrong name. This error was fatal under the rigour of ancient English law in various instances, but may now generally be amended in proceedings both civil and criminal.

Mispickel. Native arsenide with bisulphide of iron, of a tin-white colour, with a metallic lustre. It occurs chiefly in lodes in crystalline rocks, and was formerly worked in Cornwall as an ore of arsenic, much of the white arsenic of commerce being obtained from it. (Bristow's *Glossary of Mineralogy*.)

Misprision (from the Fr. mespris, *contempt* or *negligence*). In Criminal Law, in its larger sense, this term is used to signify every considerable misdemeanour which has not a certain name given to it in the law; and it is said that the offence of misprision is involved in every treason or felony whatsoever. Generally, however, by the word *misprision* is understood the contempt or neglect, that is, the nondisclosure or concealment, of any treason or felony, committed or to be committed, which a man is cognisant of, but has never assented to; for if he expressly assented, this makes him, in a case of treason, a principal, and in a case of felony either a principal or accessary, according to circumstances. Misprision of treason was made punishable under ancient statute by loss of the profits of lands during life, forfeiture of goods, and imprisonment for life. Misprision of felony in a public officer is punished by imprisonment for a year and a day; in a common person, by imprisonment generally; and in both by fine.

Missal (Low Lat. missale). The book containing the ritual for the celebration of the various masses of the Roman communion. The missals in use in different churches are not identical in all respects; but the most important part of them, the canon of the mass, as delivered in the Sacramentary of Gregory the Great, which was taken from that of Pope Gelasius in the fifth century, and which is affirmed by Roman Catholics to be a faithful representation of the ritual of the primitive church, is common to all.

Missionaries (Lat. missio, *a sending*). In ordinary language, ministers who go abroad to preach the Gospel to infidel nations. For the fields of labour, titles, and operations of the principal missionary societies now existing in and out of Great Britain, see Society.

Missions. Stations of missionaries in infidel countries. In Geography, the extensive districts formerly under the control of missionaries of the church of Rome, on the borders of the Spanish and Portuguese settlements in America, were so called. These missionaries chiefly belonged to the orders of the Capuchins, Dominicans, and Jesuits; but the latter were the most celebrated and the most successful. Their settlements in Paraguay comprehend a vast province, which they governed with independent authority: in Brazil they had also extensive districts under their control. The downfall of the order was followed by the destruction of these settlements: those of Paraguay were wholly ruined; those of Brazil, by regulations of the marquis de Pombal, were taken from their spiritual governors and placed on a new footing. Trifling relics of the missions of the other orders are still found on the banks of the Upper Amazon and Orinoco; but they have undergone severe losses from the revolutionary wars. The success of the experiment of governing the American Indians by missionaries has been the subject of much controversy. It is certain that the Jesuits succeeded better than any other governors have done in rendering them industrious, and subjecting them to discipline. But it is contended that this was only effected by an artificial system, which rendered them the servile and childish dependants of their spiritual masters, and that this slavish state was injurious to them, not only in a moral but a physical point of view, inducing premature decay; insomuch that, it is said, the population of all the missions was continually decreasing, although endeavours were made to keep it up by violent seizures of free natives, who were brought by force within their boundaries. See Charlevoix, *Histoire du Paraguay*; the *Lettres Édifiantes*: Raynal, *Histoire des Indes*; and Southey's *History of Brazil*: the two last writers espe-

cially for philosophical views on the subject, although the latter is perhaps too favourable; Marshall's *Christian Missions*; Humboldt's *Personal Narrative*, for those on the Orinoco; Forbes's *California*, for a very unfavourable view of the condition of those in the latter country, prior to the American annexation of the greater part of it. American missionaries have established a government, somewhat similar to those of the Roman Catholic orders, in some of the South Sea Islands. See Ellis's *Polynesian Researches*; the *Voyages* of Adm. Beechey, Capt. Erskine, and others.

Mist. [Fog.]

Mistletoe (A.-Sax. misteltan). A parasitical plant inhabiting the branches of many kinds of trees in the north of Europe. It is the *Viscum album* of botanists. Its connection with Druidical ceremonies is well known; but, as tradition tells us that the priests of that superstition only employed the mistletoe of the oak, some doubt had been entertained of the plant now so called being really that of our ancient chronicles, because it had not been found upon the oak for many centuries. It has, however, been recently discovered upon that tree in the west of England; and this leaves no doubt upon the subject. The powder of the leaves or shoots of the mistletoe has been used in epilepsy. [Viscum.]

Mistral. The name given to a cold north wind, which, blowing from the Alps, forms one of the scourges of Provence and the valley of the Rhône. It blows with great violence during the winter and spring months.

Misy. An impure sulphate of iron, occurring in opaque pulverulent masses of a yellow colour at the Rammelsberg mine in the Harz.

Mites (Fr. miton, Old High Ger. mîza, Gr. μῖδας). A tribe of minute Acaridan Condylopods, which do not suck their food. [Acarus.]

Mithras. The sun-god of the Persians, to which they paid adoration as the purest emblem of the divine essence. The worship of Mithras was introduced into Rome, seemingly not long after the fall of the republic, and soon spread over all parts of the empire. It was one of those which resisted Christianity the longest. The god is commonly represented as young, and kneeling on a bull which he has thrown on the ground, and which is also attacked by a dog, a serpent, and a scorpion. A specimen of such a group is preserved in the British Museum. The bull reappears in the legends of India and Europe; the serpent in those of Heracles, Vritra, Orpheus; and the dog in those of Artemis, Kephalos, Procris, &c. all solar myths. (Beugnot, *Destruction du Paganisme en Occident*; Milman's *History of Christianity.*)

Mithridate. A celebrated medicinal confection, said to have been invented by Damocrates, physician to Mithridates, king of Pontus, and supposed to be an antidote to all effects of poison and contagion; it contained seventy-two ingredients. This many-headed monster of Pharmacy is (says Dr. Heberden) a farrago that has no better title to the name of Mithridates than as it resembles the numerous undisciplined forces of a barbarous king, made up of a dissonant crowd, mighty in appearances, but in reality an ineffective multitude that only hinder each other. (*Antitheriaca*; 1745.) An amusing account of this once celebrated remedy will be found in the Introduction to Dr. Paris's *Pharmacologia.*

Mitral Valves. The valves of the left ventricle of the *heart.*

Mitre (Lat.; Gr. *μίτρα, a head band, or diadem*). The episcopal coronet. It appears to have been an ecclesiastical head covering from the earliest ages of antiquity. Pellerin says that it was worn by the regal pontiffs of the Hebrews, and with a few slight modifications was afterwards adopted by the Oriental kings and pagan high priests under the name of *cidaris*. Among the Romans the mitre was originally a sort of head-dress worn by ladies; and Servius makes it a matter of reproach to the Phrygians that they were dressed like women, inasmuch as they wore mitres. There is every reason for supposing that in England the mitre was worn by the bishops on the first introduction of Christianity into the island; and it is supposed (Gough's *Sepulchral Monuments* vol. i. p. 153) that the practice was borrowed from the apex or tutulus of the Flamen Dialis in ancient Rome. As an heraldic ornament, the mitre of a bishop is surrounded by a fillet set with precious stones: the archbishop's mitre, on the other hand, issues from a ducal coronet.

Miter. In Architecture, a junction of two pieces of wood or other material at an interior angle, by diagonal fitting.

Mitre Wheel. In Machinery, the term *mitre wheel* is applied to wheels that have their teeth set at 45° with the spindle, so as to transmit the motion to another mitre wheel and shaft placed at right angles to the first wheel.

Mittimus (Lat. *we send*). In Law: 1. A writ for transferring records from one court to another; 2. A precept under the hand and seal of a justice of peace committing an offender to his charge. [Commitment.]

Mixed Cadence. In Music. [Cadence.]

Mixed Differences. [Equation of Mixed Differences.]

Mixed Number. In Arithmetic, the sum of a whole number and a fraction. In the symbol for a mixed number the sign + is usually omitted; thus $3\frac{1}{2}$ denotes $3+\frac{1}{2}$. A mixed number can always be expressed as an improper fraction, and vice versâ.

Mizzen Mast. The name given in a three-masted vessel, or in a ketch or yawl, to the mast which supports the after sails, being nearest the stern of the ship. The word occurs in Italian as mezzana, a lateen sail, and in French as misaine, a foresail, and must be traced to the Latin medius, and the Greek μέσος; its application arising from the mizzen sail in a galley being in the *middle* line of the ship, while the other sails were carried *across* the deck.

(Gr. μνημονικός, from μνήμη, *memory*). The art of refreshing the memory in particular things by artificial aids. The common processes of tying a knot in a handkerchief, &c., will exemplify the simplest species of mnemonics, in which we endeavour to connect certain arbitrary acts with peculiar associations, so that the memory of the former may call up the latter. Some persons have taken the precaution, before delivering an address by heart, of entering the room in which it was to be spoken, and connecting in their own minds particular portions of their intended language with certain visible objects in the room. The well-known solemnities observed on the perambulation of parish boundaries, &c., form another instance of practical mnemonics, the object being to fix the memory of particular spots in the mind of those who are present. For the purpose of facilitating the remembrance of dates, names, &c. various methods have been devised by different writers (especially Feinagle and Gray in England) under the names of Memoria Technica, or Artificial Memory.

Mnemosyne (Gr. μνημοσύνη, *memory*). In the Hesiodic *Theogony*, a daughter of Uranus (the heaven) and Gaia (the earth), who became by Zeus the mother of the nine muses.

Moat (Ital. mota). A ditch made round the old castles, and filled with water. In some cases these moats still remain, as at Bodiam Castle; whilst in others they are drained and planted, as at Eltham Palace. For the most part, however, all traces of them have disappeared.

Mobility (Lat. mobilitas, from moveo, *I move*). One of the general properties of matter, in virtue of which every body at rest can be put in motion by the action of a source adequate to overcome its inertia.

The term is also frequently used to denote the absence of viscosity or oiliness in liquids; thus water, alcohol, and ether are said to be mobile, whilst castor oil and molasses are viscid liquids. [MATTER.]

Moccasins. The native name for the shoes of the American Indians. They are generally made of deer skin or other soft leather, without a sole, but ornamented on the upper side.

Mocha Stone. A white translucent kind of Agate with brown markings resembling trees and vegetable filaments. The name is, probably, a corruption of Moschus (or moss) Stone.

Mocking Bird. A name given to one of the family of thrushes, the *Turdus polyglottus* of Linnæus, on account of the surprising facility and accuracy with which it can imitate almost any sound. It is also the finest of song-birds; and the vocal organs, which are well developed in all the thrush tribe, find their highest perfection and complication in the mocking bird.

This species, in modern ornithological systems, forms the type of a genus (*Mimus* of Boié): it includes other species besides the *M. polyglottus*, all of which are natives of America. [MIMI.]

Modality. In Logic, a term applied to designate propositions in which the copula is accompanied by some phrase which adds to or restricts its meaning. Some of those phrases may be thrown into a logical shape by altering the form of the proposition. Thus the modality expressed by *must* is only the expression of a universal statement, 'Body must occupy space' being equivalent to the proposition 'All bodies occupy space.'

Mode (Lat. modus). A term used by Locke to denote 'such complex ideas which, however compounded, contain not in them the supposition of subsisting by themselves, but are considered as dependencies on or affections of substances.' Of these modes there are two kinds—*simple* and *mixed*. Simple modes are 'only variations or different combinations of the same simple idea, without the mixture of any other, as *a dozen* or *a score*, which are nothing but the ideas of so many distinct units added together.' *Mixed modes* are those 'compounded of simple ideas of several kinds put together to make one complex one—e. g. *beauty*; and consisting of a certain composition of colour and figure, causing delight in the beholder.' It need hardly be said that this distinction is founded on a very imperfect and false analysis. The term is now universally laid aside by writers on mental philosophy.

MODE. In Music, the melodious constitution or arrangement of the scale of the octave. Thus we speak of the major mode when the notes of the octave are arranged according to the major scale, and of the minor mode when they are arranged according to the minor scale.

Model (Fr. modèle, Ital. modello, from Lat. modulus, dim. of modus, *a measure*). In the Fine Arts, that which is an object of imitation. In Painting and Sculpture, it is the individual whom the artist procures for getting up his proportions, details, play of the muscles, &c. In Sculpture, the term is applied to the small sketch in wax or clay for a work of art. In Architecture and in manufacturing art, it is a small pattern in relief, either of wood, plaster, or other material, of the building proposed to be executed.

MODEL. In Mechanics, a small or miniature representation of the structure of a machine, so as to exhibit its mode of working, &c. Owing to the effect of increased mass in making the machine itself, the results obtained from the model exceed those of the machine in a greater ratio than the linear dimensions of the two works.

Modelling. In the Fine Arts, the art of forming figures in wax or in clay for making the mould from which works in plaster or other material are to be cast. In modelling in clay, that is potter's clay, the tools used are made of wood and of wire, but no tool is so good as the fingers. The clay, kept of a certain uniform moisture by constant sprinkling, or by being covered with a wet cloth or with oil-silk or an air-proof bag, is placed on a banker with

a circular revolving plinth, for the convenience of the manipulator. Clay models require interior supports, composed of a strong iron upright, and sometimes even wood also with cross bars, or the work is liable to sink or even fall to pieces, from the weight of the wet earth: the proper construction of these skeleton supports is a very essential part of modelling in clay.

Goldsmiths and medalists use wax for their models, which are commonly of a comparatively small size: the same material was used by the ancients for their small bronzes. Modelling wax consists of bees-wax melted with a small quantity of Venice turpentine, with which a little flake white in powder, or other powdered colour, is mixed, according to the tint or colour required. In wax modelling, ivory tools as well as wood are used.

Moderators, Senior and Junior. In the Universities of Oxford and Cambridge, certain public officers appointed annually to perform various duties. Their name is derived from their old office of moderating or presiding in the exercises publicly performed in the schools between undergraduates candidates for the degree of bachelor of arts. These disputations, relics of the old university system, are now reduced to little more than matters of form. *Moderator* is also the name applied to the president for the time being of the General Assembly of the Church of Scotland, and of the other inferior church courts, the synods, and presbyteries.

Modillion (Fr.). In Architecture, an ornament sometimes square on the profile and sometimes scroll-shaped, thus , with the intervention of one or two horizontal members, placed at intervals under the corona in the richer orders. They should stand centrally over columns when the latter are employed. They are simplest in the Ionic and Composite orders, much more carving being bestowed on them when they are introduced in the Corinthian. The mutule of the Doric order, which should always stand over the centre of a triglyph, is the same sort of thing as the modillion, and occupies the same place in the entablature.

Modular Focus of a Quadric Surface. In Geometry, a point-sphere which has double contact with the quadric of such a kind that the planes of contact and intersection are imaginary. The locus of all such points is called a *modular focal conic.* When the planes of contact are real, the point-sphere is often termed a *non-modular* or *umbilicar* focus. MacCullagh first introduced these terms in his theory of the *modular generation of a quadric*, which theory was afterwards completed by Dr. Salmon. [Focus.]

Modulation (Lat. modulatio, *a measuring*). In Music, the act of moving through the sounds in the harmony of any particular key to those of another; or the transition from one key to another.

(Lat. modulus). In Architecture, measure equal to the semidiameter of a column. It is by some writers exclusively applied to the Doric order; but its application

Modulus (Lat.). A term often, and sometimes loosely, used in Mathematics; in general it denotes some constant, multiplier, coefficient, or parameter involved in a given function. Thus we have the *modulus of a system of logarithms*, the *modulus of a congruence*, the *modulus of an elliptic function*, the *modulus of linear transformation*, &c., all which terms will be found defined more strictly in their respective places. Again, the positive square root of $a^2 + b^2$ is often termed the *modulus of the imaginary expression* $a + b\sqrt{-1}$; in the theory of numbers, however, $a^2 + b^2$, the square of this modulus, is called the *norm.* [Integer.]

Modus (modus decimandi, or special manner of tithing). In Law, a term used where lands, tenements, or some certain annual sum or other profit, hath been given time out of mind to a parson and his successors in full satisfaction and discharge of all tithes in kind. It is in some cases a pecuniary compensation, in others compensation in work and labour. [Tithes.]

Mœræ. [Moira.]

Mograbians or **Men of the West.** A name formerly given to a species of Turkish infantry composed of the peasants of the northern parts of Africa, who sought to better their condition by entering into foreign service.

Mogul, Great. The name by which the chief of the empire so called, founded in Hindustan by Baber in the fifteenth century, was known in Europe. The last person to whom this title of right belonged was Shah Allum; and the Mogul empire having terminated at his death in 1806, his vast possessions fell chiefly into the hands of the East India Company.

Mohair (Ger. mohr, Fr. moire, Ital. moerro, Span. muer). The hair of a variety of the common goat, famous for being soft and fine as silk, and of a silvery whiteness. It is not produced anywhere but in the vicinity of Angora, in Asia Minor. The exportation of this valuable and beautiful article, unless in the shape of yarn, was formerly prohibited; but it may now be exported unspun. The production, preparation, and sale of mohair have long engrossed the principal attention of the inhabitants of Angora; and it used to form an important article of Venetian commerce. It is manufactured into camlets and other expensive stuffs. Hitherto but little has been imported into England.

Mohammedanism. One of the most celebrated systems of religion in the world; so called from Mohammed, its author and founder, who was born at Mecca, in Arabia, in May 571. This founder of a new religion and of a political power, which even in his lifetime extended over his native country, and which under his successors threatened to overrun the world, traced his genealogy in a direct

line through eleven descents from Koreish, the founder of the powerful tribe that bore his name, and who again was affirmed to be in direct descent from Ishmael, the son of Abraham. The future prophet sprang, therefore, from the noblest tribe of the Ishmaelitish Arabs; and his grandfather was at the time of his birth sovereign of Mecca, and guardian of the *Caaba* (which from time immemorial had been identified in the minds of the Arabs with every sacred feeling); consequently, from the sanctity of his territory and his office, a prince of great power and influence. But though descended from so powerful r family, Mohammed's early life was spent in comparative dependence. He was a younger son of Abd al Motalleb; and having in his early infancy lost both his parents, his only inheritance was five camels and a female slave. On his paternal grandfather was devolved the guardianship of the fut re prophet; but of this protector he was deprived by death when only eight years of age. In a dying charge Motalleb confided this tender plant of the ancient stock of the Koreish to the hands of Abu Taleb, his eldest son, and the successor of his authority, who amply redeemed the trust reposed in him by continuing throughout life the steadfast friend of his ward amid all the difficulties and dangers to which the latter was exposed in the promulgation of his doctrines. His education, however, is said to have been extremely scanty; and at the early age of thirteen, being intended for a commercial life, he accompanied his uncle's trading caravan into Syria. He afterwards entered into the service of Khadijah, a rich widow of Mecca, to whom his skill in commerce or his other accomplishments so far endeared him that at the end of three years she bestowed upon him her hand and fortune—an alliance which restored him to the station of his family. At this period he was twenty-five, and his wife forty years of age.

During the first thirteen years of his marriage little or nothing is known of his history; but at the end of that period he withdrew from society to a cave near Mecca, where he gave himself up to contemplation. In this retirement he gave out that for two years he was in daily communication with the Deity.

In his fortieth year he assumed the prophetic office, and displayed his views and principles to his domestic circle. His first convert was Khadijah, whom he always regarded with affection, and even reverence, and whom he placed, after her death, among the only *four* perfect women the world ever saw; the other three being Miriam, the sister of Moses; the Virgin Mary; and Fatima, the youngest of his own daughters. The progress of the new sect was at first very slow. Three years were silently employed in the conversion of fourteen (some say nine) proselytes; but in the fourth year he extended the theatre of his preaching, and proclaimed his doctrines publicly to his fellow-citizens. The faith which, under the name of Islam (i. e. salvation), he preached, was compounded substantially of two great principles, which, as Gibbon says, involve an eternal truth and a necessary fiction; namely, that 'there is only one God, and that Mohammed is His prophet.' He did not, however, aim so much at founding a new religion as reforming the old, as declared by the former prophets, Adam, Noah, Abraham, Moses, and Christ, by putting an end to those superstitions and idolatries by which the true faith had been corrupted. Being urged to confirm the reality of his divine mission by miracles, he declined the attempt, appealing to the internal evidence of his doctrines, and declaring that miracles would depreciate the merit of faith. The only miracle which he professed to have accomplished is a nocturnal journey from Mecca to Jerusalem, and thence through the heavens, on an imaginary animal called Borak, i. e. lightning; but the words of the *Koran* are often regarded as figurative and allegorical. The citizens of Mecca listened to the exposition of his principles with patience till he attacked the idols of the Caaba. This, however, raised such a storm against him, particularly on the part of the Koreishites, that, notwithstanding the protection of Abu Taleb, who, though not converted to Islamism, continued the warm and steadfast protector of his nephew, many of his followers fled to other countries, chiefly to Ethiopia. This happened in the sixth year of his mission, and is called the *first Hegira*, or flight.

In the tenth year of his mission he lost both his wife Khadijah and his uncle Abu Taleb. The death of the latter being the severest blow that the new faith had yet sustained, this year is known in the Mohammedan annals as 'the year of mourning.' The death of Abu Taleb removed the only check to the virulent enmity of the Koreishites; and a stranger having succeeded to the sovereignty of Mecca, Mohammed (after a troubled residence of three years, marked, however, by the accession of many proselytes), on the invitation of a deputation from Medina, fled to that city; and instantly, as if by magic, the proscribed and condemned exile became a powerful, and, as it soon appeared, an all but invincible monarch. This flight from Mecca to Medina [HEGIRA] is the epoch from which the Mohammedans date their era. It occurred in the fifty-third year of Mohammed's age, and the thirteenth of his mission, and coincides with July 16 A. D. 622.

Hitherto Mohammed had used only persuasion and argument in propagating his religion. Throughout the eighty-five chapters of the *Koran*, published at Mecca, he exhorts his followers to bear with meekness the injuries to which their principles might expose them, declaring that he had no authority to compel anyone to embrace his creed. In the eighteen chapters published at Medina, on the contrary, he taught a very different doctrine, and announced that God had commanded him to extirpate idolatry by force of arms. The enjoyments of paradise were promised to 'those who fight for the cause of God, whether they be slain or not.' (Sura. 11. 4. 9.) Nor were those

mere words of course; they were soon reduced to practice. Mohammed, soon after his arrival in Medina, assumed the exercise both of the sacerdotal and regal office. The option of friendship, or submission, or battle, was proposed to the enemies of Islamism. His petty excursions for the defence or attack of a caravan prepared his troops for the conquest of Arabia. But what established his power, and laid the foundation of future conquests, was the issue of the battle of Bedr, near Medina, fought in the second year of the Hegira, between the troops of Abu Sophian, the new sovereign of Mecca, and his own, in which the latter, though only a third of the number of the enemy, gained a complete victory, with the loss of only forty men. From this period the progress of Mohammed, if not a complete triumph (for he sustained some defeats), affords an example of perhaps the most rapid success on record; and after the lapse of six years, in the eighth Hegira, his victorious troops entered the city of Mecca—an epoch from which may be dated the final establishment of the Mohammedan faith in Arabia. The few contests that followed were merely the last struggles of an expiring opposition, and were mostly terminated by Mohammed's generals; while the prophet himself was employed in destroying the idols enshrined in the Caaba, and in consecrating the temple to the worship of the sole God. The year following is known in Mussulman history as the 'year of embassies;' because missions were sent to the prophet from a majority of the Arabian tribes, giving in their adhesion to his creed; and recognising his authority, both sacred and civil.

But while his religion was thus triumphant, and was destined to spread still farther, the prophet's own days were drawing to a close. About three years before his death his health had been declining, in consequence of poison administered to him by a Jewess of Chaibor, in order to test the validity of his divine knowledge. But his death was occasioned by a fever of fourteen days, on June 6, 632, in the 10th Hegira, in the sixty-third year of his age. His remains were buried in Medina, in the room in which he breathed his last; and though the house itself has long since disappeared, a simple unadorned monument marks the spot where his body reposes. The pilgrim, on his way to Mecca, increases the worth of his pilgrimage if he turn aside to visit also the city which contains the ashes of Mohammed.

During the life of Khadijah, Mohammed did not avail himself of the right of polygamy: after her death, however, the restraints which policy or affection had imposed on him were laid aside, and the utmost license marked his subsequent career. While he limited the number of wives to four in the case of others, he claimed an exemption to himself on divine authority; and married no fewer than seventeen according to some authorities, and nine according to others: strangely enough, all widows except one—Ayesha, the daughter of Abu Beker. By Khadijah he had four sons, and as many daughters; and by an Egyptian concubine a fifth son: but his sons all died in infancy; and of ten daughters none survived him except Fatima, who was married to her cousin Ali. From this marriage sprang an illustrious offspring; the ancestors of the numerous existing scherifs, or sons of the prophet.

The religion of Mohammed is contained in the *Koran* (i.e. book), the contents of which, according to Mohammedan belief, are uncreated and eternal, subsisting in the essence of the Deity, and inscribed with a pen of light on the table of the everlasting decrees, and communicated at different times by the angel Gabriel. Its author appeals to the beauty of its style as a proof of its inspiration.

The object of Mohammed seems to have been to recal the inhabitants of the populous country of Arabia to a monotheistic worship, and to unite idolaters, Jews, and Christians in the same creed. He taught that the chain of inspiration was prolonged from Adam to the promulgation of the *Koran*; that Christ did not die on the cross, but that a phantom, or a criminal, was substituted in His place, and that He was translated to the seventh heaven; that Christ rejoiced in the assurance of a future prophet more illustrious than Himself; and that the promise of the *Paraclete*, or Holy Ghost, was prefigured in the name, and accomplished in the person, of Mohammed, the last and greatest of the prophets. He taught the existence of angels good and bad, and of the Devil or *Eblis*; describing the latter as having been expelled from heaven, without hope of recovery, for refusing to pay homage to Adam at the divine command. As to the Christian Scriptures, he acknowledged the Pentateuch, the Psalms, and the Gospel. The doctrine of the resurrection and the day of judgment formed part of his faith. He taught that every man shall be judged according to his works: but that the believers in Islamism shall not be subjected (like the wicked idolaters or infidels) to endless tortures, but that, after undergoing a purifying punishment, they shall be translated into the regions of bliss. He inculcated the absolute and unalterable predestination of all things. He called prayer 'the pillow of religion,' and 'the key of Paradise;' and prescribed five different stated periods of prayer daily, accompanied with as many ablutions or purifications of the body. During prayer he first insisted that the face should be turned to Jerusalem, in compliment to the Jews; but afterwards bestowed that honour on Mecca. Alms, fasting, and pilgrimage to Mecca, are the remaining duties of practical religion enjoined on all good Mussulmans. Of the last, the most holy was that of Ramadan, instituted in honour of the month in which Gabriel appeared to him in Mecca. Friday was ordained as the Moslem sabbath, because on that day he made his flight to Medina. He continued the rite of circumcision in compliment to the

prejudices of his countrymen, condemned usury, and forbade the drinking of wine.

The grossly sensual character of Mohammed's paradise constitutes, perhaps, the greatest blemish in his religious system, and has exerted a debasing influence over all the countries where it has acquired an ascendency.

After his death the rival pretensions of Abu Beker and Ali, the latter of whom called himself 'the first believer,' to succeed Mohammed in the empire he had founded, both gave a temporary check to the progress of the religion, and produced a schism which exists till the present day. [SONNITES; SCHIITES.]

Notwithstanding the high pretensions of his competitor, Abu Beker was elected to the office of supreme head of the Mussulman religion and power under the title of *caliph*, or *khalif*, i. e. successor of the prophet. Under his sway, and that of his two immediate successors, the most brilliant victories were achieved by the Arab arms. Indeed, by the 20th Hegira, or within ten years of the death of the prophet, Syria, Persia, and Egypt, being conquered, adopted the new faith. Ali was chosen the fourth khalif, but achieved nothing very memorable. At his death, which took place by the hands of an assassin, the throne was usurped by a son of Abu Sophian, whose descendants are called the Ommiad race of khalifs. They held the sovereignty for nearly 100 years; during which time the whole of Africa was overrun, and so far colonised by tribes of Bedouins that it has since remained, in language, manners, and religion, an Arab country. The Islam faith spread nearly as rapidly in the East; at least within eighty years from Mohammed's death it embraced all the countries between the Indus and the Atlantic, and from the Indian Ocean to the steppes of Central Asia. It has since penetrated even into China, and found its way into many of the islands in the Indian Archipelago. Spain was taken in 711. The Arabs were, for a short time, masters of the South of France, but were finally driven across the Pyrenees in 732. The Ommiad khalifs were, in the 133rd Hegira (A. D. 750), superseded by the descendants of Abbas, one of the uncles of Mohammed. This last dynasty is known in history as that of the Abbasside khalifs.

Meanwhile the seat of the khalifat was removed from Medina to Damascus, and latterly to Bagdad. Nor did the khalifat itself last long. It had been tottering for years; but it fell in the 656th Hegira (A. D. 1258); a Tartar army having taken Bagdad, and put an end to the nominal sacerdotal and regal power of the khalifs, the real power having, for a long time, resided in the Turkish sultans of Asia Minor. The title of khalif is now recognised as one of the attributes of the Turkish sultan as successor of Mohammed, and of the sophi of Persia as successor of Ali; but it no longer implies the discharge of any religious functions.

But neither the foreign conquests of the Mussulmans, nor the downfall of the khalifat, made any essential change in the political state of Arabia. The people adhere to Mohammedanism as the true faith, but otherwise are divided into petty tribes and communities, as before the birth of the pretended prophet. Of the two attempts made in Arabia to reform the Moslem faith, all traces of the first (A. D. 809), the object of which was to rescind the prohibition of wine, and to prevent the pilgrimages to the holy ashes, have disappeared. The other took place in more recent times; namely, in the beginning of the last century. It was made by Abdul Waheb, who proclaimed himself a prophet sent by God to reform the abuses which had been gradually engrafted on the religion of Mohammed. The chief of the Wahabee doctrines, so called from their author, was, that God was to be worshipped in the strictest unity; and that no adoration should be paid to Mohammed, or any created being. [WAHABEEISM.] But while these doctrines were rapidly spreading, and while the cities of Mecca and Medina had fallen into the hands of the new sect, Mehemet Ali, in the name of the sultan, gave an effectual check (1813) to their farther progress, and restored the holy cities to the nominal authority of the Porte. Since that time the Wahabee tenets have maintained or even increased their influence, even in Nedjed, the native province of the founder. (Abulfeda, *in Vitâ Mohammed*; D'Herbelot, *Bibliothèque Orient.*; Green's *Life of Mahomet*; the *Travels* of Niebuhr and others; Ockley, *Life of Mohammed*, and *History of the Saracens*, Burckhardt's *Notes on Bedouins and Wahabees*; Rycaut's *Present State of the Ottoman Empire*; *Lives of Mohammed* by Boulainvillier and Gagnier; Washington Irving, *Lives of Mahomet and his Successors*; Gibbon's *Roman Empire* ch. l.; Milman, *History of Latin Christianity* b. iv.; Neil's *Mohammed*; Sprenger, *Life of Mohammed*; Mill's *History of Mohammed*; Forster's *Mohammed Unveiled*; Muir's *Life of Mahomet*; *National Review*, July 1858, p. 137; Palgrave's *Journey through Central and Eastern Arabia*; M'Culloch's *Geographical Dictionary*, art. 'Arabia.')

Mohsite. A crystallised titaniferous iron from Dauphiny; named after Professor Mohs, the crystallographer.

Moidore. A Portuguese gold coin, in value 27*s.* sterling.

Moira (Gr. *a share*). In Greek Mythology, the deity who assigns to every man his lot. [FATES.] The mention of Mœræ in the plural occurs only once in the Homeric poems (*Il.* xxiv. 29), which speak of Moira generally as spinning, but assign to her no other attributes to distinguish her from Aisa; they further describe her not as an inflexible destiny, but as strictly under the control of Zeus, and influenced to a certain degree by the free will of men. In the Hesiodic *Theogony*, the Mœræ have grown into three persons (Clotho, *the spinner*, Lachesis, *the dispenser*, and Atropos, *the inexorable*), who are described as the daughters of Night. According

to later poets, Zeus and all the gods are obliged to submit to their irresistible power. [NORNS.]

Métallique (Fr.). Called in this country *crystallised tin-plate*. It presents a variegated and flowered appearance, produced upon the surface of tin-plate by applying to it in a heated state some dilute hydrochloric acid for a few seconds, then washing it with water, drying, and coating it with lacquer. The figures are more or less beautiful and diversified, according to the degree of heat and relative dilution of the acid. This mode of ornamenting tin-plate is much less in vogue now than it was some years ago.

Molars (Lat. molares, *grinders*). Teeth generally having a flattened triturating surface, and situated behind the incisors, and laniaries, when these are also present. In some Mammals, as the Cape ant-eater, all the teeth are molars. They are generally of two kinds; viz. those which are liable to be displaced and succeeded by others in the vertical direction; and those which are succeeded, and sometimes, as in the elephant and kangaroo, displaced by others developed at the back of the mouth, and advancing forwards horizontally: the first are termed premolars or false molars, the second true molars.

Molasse. The Swiss name for an extensive middle tertiary or miocene deposit widely spread in Central Europe. It is partly marine, partly fresh-water, and often contains lignite and land vegetation, especially of palm-trees. The molasse is so called as being generally a loose sand, but it varies much in texture and appearance, and not less so in its component parts.

Molasses (Port. melasses). A brown viscid uncrystallisable sugar. [SUGAR.] It is sometimes used in England in preparing the coarser sort of preserves, and on the Continent extensively in the manufacture of tobacco. It has a burnt but not a disagreeable taste.

Moldavite. Obsidian of a very dark green colour, from Moldanstein in Bavaria.

Mole (Dutch mol, Ger. maulwurf). A species of the genus TALPA [which see], common in this country and other parts of Europe. This quadruped exhibits in perfection that modification of structure by which the Mammiferous animal is adapted to a subterranean life. Its head is long, conical, and tapering to the snout, which is strengthened by a bone, and by strong gristles worked by powerful muscles. The body is almost cylindrical, thickest behind the head, and gradually diminishing to the tail. There is no outward indication of a neck, that part being enlarged to the size of the chest by the massive muscles which act upon the head and fore-legs. These, which are the principal instruments by which the mole excavates its long and intricate burrows, are the shortest, broadest, and strongest, in proportion to the size of the animal, which are to be met with in the Mammiferous class. The rapidity with which the mole can make its way through a favourable soil is such, that it may be said to swim in the earth; and, since it must displace matter so much denser than water, so do its fore-limbs display a mechanism correspondingly superior in strength to the analogous extremities or pectoral fins of the dolphin. The food of the mole consists of worms and insects: its voracity is great, and it soon perishes if food be scarce or wanting. The ardour of the sexual appetite is not less intense and characteristic of this curious quadruped. The sense of sight is very feeble, the eyes being minute and rudimental; but the other faculties of smell and hearing, as being more serviceable in its dark retreat, are extremely acute.

The female prepares a nest of dry herbage, roots, and leaves, in a chamber commonly formed by excavating and enlarging the point of intersection of three or four passages. The young are brought forth, to the number of four or five, in April, and sometimes later.

The farmer views the operations of the mole as destructive to his crops by exposing and destroying their roots, or by overthrowing the plants in the construction of the mole-hills; his burrows, moreover, become the haunts and hiding-places of the field-mouse and other noxious animals. The mole is also accused of carrying off quantities of young corn to form its nest. Hence, every means are devised to capture and destroy it, and men gain a livelihood exclusively by this occupation. Some naturalists, however, plead that the injury which it perpetrates is slight, and that it is more than counterbalanced by the benefit which it produces by turning up and lightening the soil, and especially by its immense destruction of earth worms, and many other noxious animals which inhabit the superficial layer of the ground, and occasion great injury to the roots of grass, corn, and many other plants. The soundest practical conclusion lies probably in the mean of these opinions; and the enlightened agriculturist, while he takes prompt measures to prevent the undue increase of the mole, would do well to reflect on the disadvantages which might follow its total extermination.

MOLE (Ger. mahl, Swed. mål, *a mark* or *spot*; hence perhaps the English form iron-*mold*: Wedgwood). Different productions of and excretions from the uterus are so called by medical writers. Small soft excrescences of the cuticle are also termed *moles*.

MOLE (Lat. moles, *a mass*). In Engineering, a massive work formed of large stones placed in the sea by means of coffer-dams, extended either in a right line or an arc of a circle before a port, which it serves to close, and to defend the vessels in it from the impetuosity of the waves, &c. It is sometimes used synonymously with *harbour*.

Molecule (Lat. molecula, dim. of moles, *a mass*). This term is frequently misused as synonymous with *atom*. In its strictly chemical sense, however, it means the smallest quantity of an element or of a compound that can exist in the free state. This quantity is, in the case of compounds, sometimes a

single atom; thus ammonia (NH_3) is both a molecule and an atom. But the molecule of most, probably of all, elements consists of two atoms; and this is also generally the case with so-called compound radicals, which play the part of elements; thus the molecule of hydroxyl ($O_4 H_2$) consists of two atoms of O_2H. The molecule of ethyl is also double, $\left\{\begin{matrix} C_4 H_5 \\ C_4 H_5 \end{matrix}\right.$.

Molinism. In Roman Catholic Theology, a system of opinions on the subjects of grace and predestination somewhat resembling those of the Arminian party among Protestants. It derived its name from the Jesuit Louis Molina, professor of theology in the university of Evora in Portugal, who laid down a series of propositions on these debated questions in his work entitled *Liberi arbitrii cum gratiæ donis, &c., concordia,* which appeared in 1588. He was attacked by the Dominicans on the charge of having advocated in it Pelagian or semi-Pelagian sentiments, and accused before the Inquisition: he appealed to Rome, and the cause was debated for twenty years in the congregations, and left at last undecided by a decree of Paul V. in 1607. Since that period Molinism has been taught as an opinion which believers are free to embrace in Roman Catholic schools, and generally supported by the Jesuit and attacked by the Jansenist party. It must not be confounded with *Molinosism*—a name which the doctrine of the Quietists has received from the work of a Spanish enthusiast (Molinos) on Mystical Life, condemned in 1687 by Innocent XI. The French Quietists professed to abjure and oppose the errors of Molinos. [QUIETISTS.]

Moliones. [THOR.]

Molisite. A mineralogical synonym of the crystallised titaniferous iron of Dauphiny.

Mollah. The title of the higher order of judges in the Turkish empire. After the three first magistrates of the empire (the two cadi leskers of Roumi and Anatolia, and the istambol-cadissy or chief ordinary judge of the capital) follow fourteen mollahs, who preside over the fourteen principal seats of justice in the empire; among these, the mollahs of Mecca and Medina have the highest rank. The place of mollah, like all others in the Turkish empire, is held only at the will of the sovereign, and is now granted annually (D'Ohsson, *Tableau de l'Empire Ottoman,* vol. iv.); but displaced mollahs preserve their rank in the Ulema above their successors. The Turkish mollah must not be confounded with the Tartar mulla.

Molluscs or **Mollusca** (Lat. from mollis, *soft*). The name applied by Cuvier to the great primary division of the animal kingdom which includes all species having a gangliated nervous system, with the ganglions or medullary masses dispersed more or less irregularly in different parts of the body, which is soft and inarticulate. The pulmonary or branchial circulation is separate and distinct, but is aided by the direct propulsion of a heart in one class only. There is always a heart for the systemic circulation, and it mostly consists of one ventricle and one auricle. Some of the molluscs breathe air, but the greater part respire through the medium of salt or fresh water. The blood of the molluscs is white or bluish. In one class only is there a rudiment of an internal skeleton giving attachment to a part of the muscular system; in the rest it is absent, and the muscles are attached to various points of the skin. Their contractions produce inflexions and extensions of their different parts, and, alternating with relaxations, enable the species to creep, climb, swim, burrow, and seize upon various objects, as the form of these parts may permit; but as the locomotive organs are not supported by articulated and solid levers, the molluscs cannot leap or advance rapidly on dry land. Many of the aquatic species are encumbered with a heavy shell. Nearly all the molluscs have an extensive fold of the skin reflected over their body, which it covers like a mantle; it is sometimes produced into a breathing-pipe, or extended and divided in the form of fins. When the mantle is simply membranous or fleshy, or when a horny or testaceous rudiment of a shell is developed, but remains concealed in the substance of the mantle, the mollusc is said to be *naked.* When the shell is so much enlarged that the contracted animal finds shelter beneath or within it, the species is said to be testaceous. [CONCHOLOGY.] The masticatory or oral organs present all the various modifications for predatory, omnivorous, or herbivorous habits; and the stomach may be simple, multiple, or complicated with a peculiar armature.

Some of the molluscs are unisexual, others androgynous, a few diœcious. With few exceptions, their habits and economy present comparatively little variety or interest, and they are only preserved by their fecundity and vital tenacity. [MALACOLOGY.]

Moloch. The name of the chief god of the Phœnicians, frequently mentioned in Scripture as the god of the Ammonites. Human sacrifices were offered at the shrine of this divinity; and it was chiefly in the valley of Hinnom, to the east of Jerusalem, that this brutal idolatry was perpetrated. The Topheth (for it is always mentioned with the article) was a place in the east end of this valley, where the children were first killed, and then thrown into the abyss of fire, under an image of Moloch. Solomon built a temple to Moloch upon the Mount of Olives, and Ahaz, Manasseh, and other kings imitated his impiety by making their first-born sons pass through the fire kindled in honour of this horrid king. At Carthage, during the invasion of Agathocles, either 200 or 500 children were offered in a single sacrifice to Moloch. (Grote's *History of Greece,* part ii. chapter xcvii.) The word *moloch,* signifying king, occurs commonly in the composition of Hebrew names, as in Melchizedeck, Melchishua, &c., and reappears in Milcom, and in Adrammelech, and Anammelech, the gods of Sepharvaim.

The frequency of human sacrifices in Jerusalem is proved by the incessant remonstrances of the prophets, who, upbraiding their countrymen for the shedding of innocent blood, stigmatised Jerusalem as a bloody city.

(Gr. *μολοσσός*). In Greek and Latin poetry, a foot consisting of three long syllables, as *Σαρπηδών*, *regnabant*.

Molybdenite. Native sulphide of molybdenum.

Molybdenum (Gr. *μόλυβδος*, *lead*). This name was originally applied to the native sulphide of molybdenum, which was considered to be an ore of lead, but was afterwards shown to contain a peculiar metal. Molybdenum is white, brittle, and very difficult of fusion. It forms two oxides and an acid (*molybdic acid*). The compounds of the latter are called *molybdates*. The molybdate of lead has been found native.

Molybdine. Native molybdic acid.

Moment (Lat. momentum, from movere, *to move*). Confusion rather than clearness would be the result of an attempt to explain the various significations of this term as used by older writers on mechanics; we shall, therefore, give separately the more modern interpretations of the term in its various combinations.

As applied to *time*, the term *moment* is synonymous with *instant*, and denotes a brief but indefinite period.

Moment of a Couple. The product of either of the two equal and opposite forces, of which the couple consists, into the distance between their lines of action. [COUPLE.]

The *moment of a force with respect to a point* is the product of the force into the distance of the point from its line of action.

The *moment of a force with respect to a plane* is the product of the force into the distance of its point of application from that plane.

The *moment of a force with respect to a line* is found by first resolving the force into two components, one parallel and the other perpendicular to the line, and then taking the product of the latter component into its distance from the line.

Moment of Inertia. [INERTIA, MOMENT OF.]

Moment-axis of a Couple. The finite line which represents, by its magnitude and direction, the moment and *rotation-axis* of a couple. [COUPLE.]

Momental Ellipsoid. [INERTIA, MOMENT OF.]

Momental Plane. In Statics, the plane of the couple which, together with a force of translation, is equivalent to a given system of forces, is called the *momental plane* of the point (*moment-centre*) in which it is intersected by the force. [FORCES, COMPOSITION AND RESOLUTION OF.]

Momentum (Lat.). In Mechanics, denotes the product of the mass of a body into the velocity with which it moves. It is also called the *quantity of motion*.

(from the Fr. momerie, Ang. *mummery*). The name by which certain religionists of the so-called Evangelical party have been designated in Switzerland, and some parts of France and Germany, since 1818. They appear originally to have resembled the Methodists of our own country; for, like the latter, they at first embraced no tenets distinct from those of the established church, and were only distinguished from its members by more frequent religious exercises. But they did not long continue to harmonise with the preachers of the establishment. One of the most vehement of the party, in a pamphlet published in 1818, accused the latter of denying the divinity of our Saviour, and of a thorough backsliding from the doctrines of Calvinism; and the Geneva clergy (*la vénérable compagnie*), having passed a resolution prohibiting any theories on the doctrinal points of religion from being propounded in the pulpit, and having counselled the clergy to avoid disputed points as much as possible in their discourses, the smouldering embers of their hostility burst into a flame. They now began to attack the clergy in the pulpit and in pamphlets. But all their efforts to bring the latter into contempt were unsuccessful: the Genevese remained faithful to their pastors; and in the year 1835 the Momiers possessed only about 200 adherents.

In other parts of Switzerland, however, and more especially in the canton de Vaud, the zeal of these sectaries was attended with more success. After a few years' toleration of their preaching and proselytising, during which it was alleged the Momiers had caused the greatest discord among the inhabitants of the canton, the government at last saw the necessity of interference; and in the year 1824 promulgated some vigorous ordinances to put them down. These enactments, as might have been expected, failed of their effect. The enthusiasm of the Momiers was redoubled: they were now surrounded with the glory of martyrdom; and many who before had viewed their zeal with indifference now sympathised in what they could not but regard as an attack upon the liberty of conscience. In consequence of the general disgust that ensued on their promulgation, these ordinances were at first gradually relaxed, then suffered to lie dormant, and at last repealed in 1831. Since that period the number of the Momiers has gradually diminished; and in 1839 the clergy of this canton resolved by a large majority to revert to the ancient system of the church. (*Edinburgh Review*, vol. xlii.)

Momus (Gr. *μῶμος*, *derision*). The god of raillery and ridicule, said by Hesiod to have been the progeny of night.

Monachism, Monk, Monastery (all derived from the Gr. *μόνος*, *alone*). Words indicative of certain important features in ecclesiastical history. The word monachus, or monk, properly signifies one who lives a solitary life, and was applied in the first instance to the

many persons who began in the second and third centuries to retire from the occupations of the world, and devote themselves in the deserts of Egypt and Syria to a contemplative and religious life. It was not till the middle of the third century that the monkish system, properly so called, was established, by which many persons were congregated together, and bound by vows to the performance of various religious duties. These monks are distinguished by the appellation of Cœnobites, or Associates, from the ascetics, anchorites, and hermits, who lived apart not from the world only, but from each other. The inmates of the primitive monasteries were bound by the profession of four objects: solitude, labour, fasting, and prayers. But although the objects at which they aimed were theoretically the same, the history of monachism was very different in the East and the West, and exhibits commonly a succession of varying phases in each country where it took root. The great type of Western monachism is St. Bernard, that of the Eastern is St. Anthony; but while the monachism of the latter differs little or perhaps not at all from that of the wildest Oriental fakir, the former guided the world to which professedly he did not belong, and wrote from his cell letters of counsel to the vicar of Christ, of rebuke to kings and statesmen, and of warning to the faithful and the unbelieving. The monachism of the East had its origin in that idea of DUALISM which underlies almost every form of Oriental philosophy. It sprang not from any abstract love of solitude, but from a belief in the absolute and hopeless corruption of matter. So far from holding with Christian theologians that material corruption was the effect of moral disobedience, the disciples of Anthony, like those of Buddha [BUDDHISM], looked upon matter as evil, not as having been defiled by a perverted use, but as being in itself the work of an evil god, the principle of defilement to everything associated with it. The Nitrian anchorite fled from society not so much because solitude was necessary, as because only in solitude he could preserve unsullied the treasure of virginity, which seems almost the one idea infused by Christianity into the monastic theory. But the western monks were the members of a society, the soldiers of an army which was to fight the battles of the King of kings; and thus their most prominent characteristic, in contrast with the grovelling asceticism of the East, is power. This power has been one of the greatest props, at one time it may be said to have been the only prop and safeguard of the Papacy. With the rise or degeneracy of the great orders rose or fell the dignity and power of the popes, who with a true instinct took into their special favour the men whom they knew to be the chief bulwarks of their supremacy; and in its turn the character of the popes, or rather of their designs, and the condition of their spiritual empire, exercised a corresponding influence on the monastic orders. While, then, the common asceticism of the learned Benedictine and of the hermit who gloried in his ignorance connects the theory of Christian monachism in every shape with the remote philosophy of the East, the circumstances of European society soon turned into a different direction the fire which had been kindled by the eloquence of Athanasius. From him came the impulse which sent the descendants of the old Fabii and Claudii to a life of prayer and penitence at Bethlehem; but while Jerome drew his spiritual colony to Palestine, Ambrose and Martin of Tours were infusing fresh life into the monasticism of the West. The wildest recesses of Gaul were peopled by fervent hermits, who only thought the fare too soft which kept in life the eremites of Egypt. The philosophy of Cassianus drew down suspicion on the convent of St. Victor at Marseilles; while on the heights of Jura Lupicinus rebelled against the light austerities of his brother Romanus. 'Into one cauldron he threw a meal of fish and vegetables which the monks were preparing separately with some neatness and care: and twelve of the brethren left the convent in indignation. "Better were it for thee not to have come here," said Romanus, "than thus to drive away our monks." "It matters not," was his reply; "it is the chaff separating itself from the wheat: God has no portion in them."'

Thus far the growth of Western monachism was rapid but irregular. The abbeys were isolated units with no common centre of action; and if the monks were to carry the world through the dissolution of the old society, it could only be done by their assuming the compact organisation of an army. The crisis was momentous; and it produced St. Benedict. In his wild Nursian retreat he framed a rule for the disciples who thronged to him; and that rule made the act of profession the last exercise of a personal will permitted to the monk, while the perpetuity of the organisation was secured by an absolute and irrevocable renunciation of all property. This form of organisation attracted into the monastic army the first monk who sat on the throne of St. Peter. Thus disciplined, Gregory the Great was enabled practically to seize the prerogatives of the Western emperors, while Maurus issued from Monte Cassino to carry the Benedictine rule into the North. In Gaul the abbeys of Marmoutier and Condat, and the names of German and Gregory of Tours, of Gall and Columba, attest the activity of the monastic principle in the age of Thierri and Brunehault, Agilulf, and Clotaire.

But if the monks of the earlier centuries had vastly extended the sway of the papacy, monachism again came to the rescue when its vices seemed to be growing too heavy for the world to bear. The crusades against Albigensians and Waldensians, and the slaughter of Arnold of Brescia for denouncing the unblushing profligacy of the time, would alone suffice to show the gravity of the crisis. Men were gradually becoming tired of the lavish use of fire and sword as the regular arguments to be

employed against heretics and unbelievers by priests whose lives were a disgrace to Christianity and humanity alike. In this hour of peril Dominic and Francis came forth to fight with other weapons; and the vow of absolute poverty was added to the vows enjoined by all existing monastic rules. [ORDERS, MENDICANT.] But if the Mendicant order so established became mighty props of the papal empire, they also introduced new sources of weakness. Their very institution was a satire on the secular clergy, and even on the great monastic bodies. The jealousy of faction took the place of former unity; and the celibate secular clergy, the great army of Hildebrand, found their loyalty cooling down, as they were confronted by these professors of a more austere and less worldly system. But the history of the old orders was in the issue repeated in that of the Mendicants. They had forsworn power: they grasped it with greater tenacity than any who had gone before them. Spacious buildings sheltered men who had sworn to live without house or home. They had abjured art and learning; and from their ranks came forth men famed throughout the world for their skill in the former and their attainments in the latter. Over the bones of Francis rose the church of Assisi, rich with gold, azure, and vermilion; and men gazed with devotion on the angelic countenances and placid forms which looked down upon them from walls and tablets, or stood astonished at the science of Thomas Aquinas and Albert the Great.

It is unnecessary to prolong the tale. It has become almost a truism to say that the church and the monastic orders alike exhibit periods of energy followed by ages of sloth, to be succeeded perhaps by an era of renovation. The story of these changes is vividly related by Dean Milman (*Latin Christianity*) and M. de Montalembert (*Les Moines d'Occident*). (*Edinburgh Review*, Jan. 1858, p. 78 &c. and Oct. 1861, art. 'Monks of the West.')

Monad (Gr. μονάς, *a unit*). In Metaphysics, this word has been used by Leibniz and his followers, partisans of what has been called the Monadic Theory. 'After studying,' says Stewart, 'with all possible diligence, what Leibniz has said of his *monads* in different parts of his works, I find myself quite incompetent to annex any precise idea to the word as he employed it.' He then quotes the following as 'some of his most intelligible attempts to explain his meaning:'—'A simple substance has no parts: a compound substance is an aggregate of simple substances, or of monads.' 'Monads, having no parts, are neither extended, figured, nor divisible. They are the real atoms of nature; in other words, the elements of things.' 'Every monad is a living mirror, representing the universe, according to its particular point of view, and subject to no regular laws, as the universe itself.' 'Every monad with a particular body makes a living substance.' (*Ency. Brit.* Preliminary Dissertation.) The groundwork of the monadic theory is to be found in the different philosophical systems of Zeno, Leucippus, Democritus, and Epicurus; but Leibniz was the first who reduced it to a system.

Monadelphous (Gr. μόνος, and ἀδελφός, *a brother*). In Botany, a term applied to stamens the filaments of which are combined into a single mass, as in the Common Mallow. *Monadelphia* is the name of one of the classes in the Linnæan system.

Monandrous (Gr. μόνανδρος). In Botany, a term applied to a flower having but one stamen. *Monandria* is the name of the first class in the Linnæan system.

Monarchians. In Ecclesiastical History, a name given to a theological party in the third century, which asserted one immutable primary principle in the Godhead, and charged those who could not define the subordination of the Son to the Father as being ditheists or worshippers of two Gods. Their opponents accused them of believing that the Father must have suffered on the cross, and hence branded them also with the name of Patripassians. (Milman's *Latin Christianity*, book i. ch. i.)

Monarchy (Gr. μοναρχία, *the rule of one*). The government of a single person. Monarch and monarchy are equivalent in common speech to king and kingdom; so that we often read of the Spartan monarchs, &c., although the government of Sparta was under a double race of kings reigning at the same time. Monarchies are usually said to be of four kinds—*absolute*, *limited*, *hereditary*, and *elective*, which are self-explanatory terms. The only elective monarchy in Europe was that of Poland. All absolute and limited monarchies have adopted the hereditary principle. [LIBERTY.]

Monas (Gr.). A genus of extremely minute polygastric Infusores.

Monastery (Gr. μοναστήριον). The general name for religious houses appropriated to the reception and maintenance of monks and nuns, but especially of the former. For an account of the origin and object of monasteries, see MONACHISM, and the authorities there referred to; and for the habits, rules, and peculiarities of the different orders of monks and nuns, see the respective articles, but more especially ORDERS, RELIGIOUS. The English term *monastery* was variously rendered by the Greek fathers; thus we find it expressed not only by μοναστήριον and μονή, but by σεμνεῖον, *a holy place*, μάνδρα, *an inclosure*, φροντιστήριον, *a place of meditation*, &c. The suppression of monasteries was one of the first consequences of the Reformation in all the countries that abandoned the Popish faith. But even in Roman Catholic states, with the exception of Italy, they have long been on the decline although since the relaxation of the penal laws several monasteries and nunneries have been established in various parts of Great Britain. [MINSTER.]

Monazite (Gr. μονάζω, *I live alone*). A native phosphate of cerium, lanthanum, and thorium, found near Slatoust in the Ural.

Monday. The second day of the week is so called, and means, literally, the *day of the moon*. Its equivalents in French and German are respectively Lundi and Montag, signifying also *day of the moon*.

Moneta. In Latin Mythology, an epithet by which Juno was described as the protectress of *money*. The name may perhaps belong to the same root with MINERVA.

Money (so called from the temple of Juno *Moneta*, in which money was first coined at Rome). In a previous article, CURRENCY, we have called attention to the causes which led all civilised societies into the selection of certain articles as media of exchange, or as representatives of value. These articles are not necessarily metals, for salt, it is said, is used as a medium in Abyssinia; dried cod in Newfoundland; and for ages a small univalve shell, under the name of *cowrie*, has been employed as a medium of exchange in the Indian peninsula. But where metals can be obtained in sufficient plenty for the purpose they have been invariably employed; and among metals, gold, silver, and copper have been almost universally selected, the principal reason for the choice being, that these articles are generally procurable in nearly equal quantities at nearly equal cost, and therefore present, at times not too remote, nearly equal intrinsic or market values; the market value of a commodity, as measured by itself only, being determined entirely by the cost of production. This rule applies in early metallurgy to copper as well as to gold and silver: for of all metals, gold excepted, none is found native so frequently as copper; and gold, though a metal of very wide geological distribution, has not been found, or not been found in any quantity, in those countries which, like ancient Rome and Sweden, originally adopted a copper currency as the basis of their monetary system.

So essential is the adoption of a currency, and, when the choice is given, of a metallic currency, to commercial progress, that we may lay it down as a principle, that just as the developement of language is essential to the intellectual growth of a people, so is a medium of exchange essential to civilisation. In fact, no community has ever been capable of reclamation, or of political existence by the side of other men, which fails to adopt, or is incapable of appropriating, a means of exchange. There is, too, a peculiar fitness in the selection of gold and silver. In the first place, gold is generally discovered superficially in a metallic form, and after laborious search, the area over which it is produced being ordinarily limited to the detritus of primitive rocks, or in smaller quantities in the substance of the rocks themselves, from which it must be extracted by great labour. No deep gold mines have, it appears, ever been found. On the other hand, the geological area of silver is much wider. It is less frequently found native, is commonly associated with the ores of other metals, though generally reduced with ease, and is often procured by deep mining. Sir R. Murchison has called attention to this physical relation of the precious metals, and noticed the language of the book of Job as illustrating the different geological sources of gold and silver with exact precision. 'Surely there is a vein for silver'—'the earth hath dust of gold.' (Job xxviii. 1–6.) Hence while sudden accessions have been made from time to time to the quantity of gold in circulation and for employment in the arts, the working of silver mines, and especially the extraction of this metal from argentiferous galena, one of its most prolific sources, has been carried out simultaneously, and to such an extent, as rapidly to counterpoise any disturbance of the mutual values of gold and silver. For although there is not and never can be any precise ratio of intrinsic value possessed by each of the two precious metals, yet, in modern times at least, the margin of oscillation is so narrow, that with due precautions both may be used simultaneously as media of exchange, the one for large, the other for small values. The double or triple circulation of the metals gold and silver, or gold, silver, and copper, may be effected by adopting the rule employed in this country, of taking one among these metals, either gold or silver, as the commodity in which values are expressed and obligations created, and by bestowing on the other metals, when put into circulation, a larger value than that which they naturally possess or could possess, and depriving them of what is technically called the privilege of legal tender, that is the being presented compulsorily in liquidation of a debt.

Besides the quality essential to the function of a means of exchange, that of its being produced in nearly equal quantities at nearly equal cost, the precious metals have other characteristics second in importance only to that which has been already named. They are comparatively speaking indestructible, and therefore can be at once treasured up for an indefinite period, and by transfer from hand to hand are capable of effecting an indefinite number of exchanges. No perishable commodity could form a monetary unit; the acceptance of money being founded on the condition that the recipient can at a future period employ it for as many, or nearly as many, commodities as he could have obtained with it when he first accepted it in satisfaction of an obligation. The fundamental characteristic of money would be lost, if it were liable to spontaneous alteration, waste, or decomposition. Again, it must be homogeneous, or of equal value throughout its whole substance. Next, it must be easily susceptible of division and reunion. Precious stones might for certain purposes be made media of exchange, possessing as they do high value in small compass, and therefore the characteristic of easy transport from place to place. But the mass of gold or silver may be divided into small portions, and so be made available for small transactions; and as these portions may be readily reunited by fusion,

with no loss in the process beyond that involved in the labour which had previously divided the mass or ingot, the aggregate of small pieces is of no less and of no greater value than the original and undivided quantity. Now as many articles of value do not possess these qualities at all, and as none possess them all, it is no wonder that, since a medium of exchange in order to be perfect requires all these characteristics, all societies have, spontaneously and as if by instinct, adopted the precious metals as their money.

It is generally taken for granted, that in early ages the practice of paying in money by weight is a proof that coins in the strict sense of metallic masses of certified weight and purity were unknown. It is difficult to see, however, how mere masses of bullion could have answered the purpose of payment at all, except as a kind of barter, of a more difficult and precarious character than barter in any other commodity. It cannot, indeed, be asserted that coinage and a metallic currency were contemporaneous; but the mere practice of weighing money is no proof that a coinage did not exist, since the acceptance of money by tale indicates not only confidence in the authority by which it was first issued, but trust in the integrity of the person from whose hands it is received; and it is perfectly certain that the habit of weighing sums of coined money continued for ages after it is notorious that coined masses were issued. Nor is it remarkable that writers have assigned the invention of a coinage to certain definite persons, as to Pheidon in Argos, Darius in Persia, and the like. In ancient history, and, indeed, in modern history too, the disposition to identify a practice with a particular date and a particular individual is so strong, that statements to such an effect are readily made and as unhesitatingly accepted. Of one thing we may be quite sure, that the greater part of the advantages of a metallic currency, or money proper, are lost in the absence of a coinage, and that when the precious metals were first adopted as a means of exchange no long time could have elapsed before the obvious and essential advantages of a coinage were recognised and adopted. It is probable that the use of the precious metals for purposes of exchange had a beginning in historical times; but it is very improbable that the practice should have been adopted, and yet that for centuries nations should have been content with so rude a system of exchange as bartering quantities of commodities for rude ingots, and failed to see the advantage of a coined currency. Nor is the negative argument of the absence of early specimens of coins of any vital significance, unless we conclude that the habit of hoarding and hiding specie is of universal force.

A coined piece of money is a mass of metal issued by an authority which gives a practical guarantee of its weight and fineness. As we have observed, the latter is of greater importance than the former, the practice of weighing the precious metal, even when coined, having long survived after coinage had been familiar to society. But the security given in a coin, that the fineness of the metal is according to an intelligible standard, is so important, and the policy of keeping that standard unchanged of such paramount prudence, that, however much governments have tampered with the weight of the nominal quantity, they have seldom, unless thoroughly demoralised and desperate, ventured on altering or debasing the standard; and when they have done so, the result has been in the last degree ruinous. For although it may be true that after all a coin differs in name and designation only from a mass of bullion, and the barter of commodities for coins is ultimately only an act of simple exchange, yet the coin, if it be issued by a sufficient authority, is effectually a manufactured commodity, the market value of which for the time being is precisely known and generally intelligible, and which owes the readiness of its acceptance to the fact of its being manufactured and appreciable by common understanding.

Hence, in order to obviate the endless confusion and inconvenience that could not fail to arise if individuals were permitted to coin money, from the circulation of coins of all weights and degrees of purity, the government of every civilised country has generally prohibited the issue of coins by private parties, and has itself supplied those in circulation. In accordance with the same policy severe penalties have been inflicted on the forgers of coin, or on those who fabricate counterfeit coins, or coins of less weight than the standard, or made up in whole or in part of some baser or less valuable metal. It is found, however, that the improvement of the fabric of the coins, by the perfecting of the dies and otherwise, is a more effectual means than even the utmost severity of punishment for the prevention of forgery.

Where the use of coins has once been adopted, all values in contracts and other engagements are rated or estimated in money; and it is usual in almost all countries to enact that coins of the legal or standard weight and purity shall be *legal tender*, and to declare that no legal proceedings of any kind shall be instituted on account of any debt or pecuniary obligation against any individual who has offered to liquidate the same by payment of an equivalent amount of the recognised coin of the country. A pound troy, or 12 oz. of the metal of which English silver coins are made, contains 11 oz. 2 dwts. pure silver, and 18 dwts. alloy. This pound is coined into 66 shillings; so that each shilling contains 81·09 grains fine silver, and 87·43 grains standard silver; and the money pound, consisting of 20 shillings, contains 1618·59 grains pure silver, and 1748·6 grains standard silver. From 1600 down to 1816, the pound weight of standard silver bullion was coined into 62 shillings. All the English silver coins have been coined out of

silver of 11 oz. 2 dwts. fine, from the Conquest to this moment, except for the short period of sixteen years from the 34th Henry VIII. to the 2nd Elizabeth.

The fineness of gold is estimated by carat grains equivalent to 2½ dwts. troy; gold of the highest degree of fineness, or pure, being said to be 24 carats fine. The purity of our present gold coins is 11 parts fine gold or one part alloy. The sovereign, or twenty-shilling piece, contains 113·001 grains fine gold, or 123·274 grains standard gold. The pound troy of standard gold is coined into 46 sovereigns and $\frac{89}{120}$ths of a sovereign, or into 46*l.* 14*s.* 6*d.* The Mint or standard price of gold is therefore said to be 46*l.* 14*s.* 6*d.* per pound troy, or 3*l.* 17*s.* 10½*d.* an ounce. The alloy in coins is reckoned of no value; it is allowed in order to save the trouble and expense that would be incurred in refining the metals to their highest degree of purity, and because when its quantity is small it renders the coins harder, and less liable to be worn or rubbed. Were the quantity of alloy considerable, it would lessen the splendour and ductility of the metals, and would add too much to the weight of the coins.

The unit of money accounts in all countries seems to be arbitrary and artificial. In Greece, it was the drachma, a silver coin; in Rome, the as, a copper coin. No rational interpretation has been given of this selection, and indeed the weight of the drachma of Greece varied in the Doric and Ionic races. The mina and talent, moneys of account, appear to have been derived from the Eastern world.

In Western Europe, the pound, libra, a weight apparently of Sicilian origin, was almost universally adopted, though the weights assigned to this quantity exhibit considerable variations. It is hardly necessary to say that the pound of silver was never coined in mass, but was only, like the Greek talent and mina, a money of account.

The English system attempted in some degree to unite the traditional pound with a natural system of weights. The pennyweight was defined by law to be 32 grains of wheat taken from the middle of the ear. Mr. Norris (*Phil. Trans.* 1775) subjected this rude estimate to a practical test. He weighed 96 grains of wheat of the harvest of 1773, and found that 32 of them taken at random weighed 22·5 grains troy, and 240 such pennyweights were equal to 5,400 grains troy, the weight of the Saxon pound, which stood to the troy pound in the proportion of 540 to 576, and to the avoirdupois pound in that of 54 to 70. The troy pound was substituted for the Saxon pound by Henry VII.

The moneys of various European countries have been degraded at various successive epochs. The degradations of the English mint will be found in the table given below. The Scotch currency had fallen at the time of the Restoration to a thirty-sixth of its original value; the English to a third. The French, whose franc or livre is the shrunken substitute of the ancient pound, contains little more than a seventy-fifth of the original quantity. It appears that the degradation has been carried still further in some parts of the Continent. The separate coinage of Scotland ceased at the Union; that of Ireland, in which kingdom the gold and silver coins were nominally rated 8⅓ higher than their English equivalents, was made identical with the currency of the United Kingdom by the Act 8 Geo. IV. c. 79. It is hardly necessary to say, that so barbarous a system as that of a different currency in three states forming for political purposes a single community ought not to have been retained an instant after the union was effected.

It is generally supposed, that the successive degradations of the monetary unit were the expedients of bankrupt and dishonest governments, who practised on the ignorance of communities, by abstracting a portion of the customary quantity of silver from their new issues, and were thus able by successive diminutions to reduce the metallic value to one-third of its original weight. But it may be doubted that the community was ever so ignorant as to be taken in by so transparent a fraud, or that any government was ever so suicidal as to cripple its future resources for the sake of temporary and slight relief. In all likelihood payments were made by weight, the impress on the coin having no further necessary significance than a pledge of the fineness of the standard. It is, indeed, only on the presumption that accounts in specie were really kept by weight, that we can explain those facts of the fifteenth century which caused so great a difficulty to Adam Smith—the low price of corn, the apparent degradation of the currency by 25 per cent., and the high price of labour. Nor is it likely that the parliament which took so independent a position in the fifteenth century, would have been silent during these successive frauds, when it dwelt with so much freedom on acts of the crown of far less importance; nor that the crown, a large portion of whose revenues was derived from fixed rents, fines, and reliefs, should have met a temporary difficulty by a permanent loss; especially as the new issue would, on the hypothesis of its circulating at the same nominal value as the old, have banished the latter from sight, and have been necessarily received in payment of taxes. We may be quite certain, that there is nothing which is so rapidly, so clearly, and so effectually understood, as any fraudulent issue of a light currency.

The debasement of the currency, that is the issue of base money, has been occasionally practised by governments. Its consequences are in the highest degree and immediately disastrous. Much of the misery which befell France during the fourteenth century was ascribed to this pernicious practice, for at the time the great peers of France possessed the right of coining money, and both monarch and grandees debased the currency without scruple. In

England the worst effects followed from the adoption of this expedient by Henry the Eighth and the Protector Somerset. It is probable that no act of government in this country ever produced such wide-spread distress as the gigantic debasement committed by Henry the Eighth. It is certain that there was never in those evil times so gross a deed of monstrous and insolent tyranny. The first subjoined table will inform the reader of the extent to which the debasement was carried. This spurious money was called in by Elizabeth, was purchased compulsorily at even less than its intrinsic value, and fell little short in nominal amount of three-quarters of a million. The modern system of English money dates from the restoration of the currency at the commencement of Elizabeth's reign.

When gold and silver are equally a legal tender, i.e. when the proffer of either in liquidation of debts is a bar to action, it is necessary that their mutual value should be fixed by government; and payment in either should be determined by a fixed proportion. Attempts were made, though without success, to fix such a proportion from the earliest times in which gold has been coined in this country, though finally the regulations have been so far effectual as to induce the substitution of gold for silver as a legal tender or as a standard of value. [Currency, Double.]

In England the over-valued metal was gold, and apparently the proportion fixed became progressively more unfavourable to silver. Hence the substitution of gold for silver in all large payments, and ultimately its sole recognition as a standard.

In France the reverse error was committed. Silver was over-valued, and in consequence gold disappeared from circulation. But as the proportion established by law remains unaltered, and the option of payment in either metal is still left to the debtor, the large accessions of gold to the circulating medium by the discovery of mines in California and Australia have reversed the phenomenon, and silver is rapidly disappearing from France. Considerable attention has been called to this fact by the publication of a treatise on the gold discoveries, from the pen of M. Michel Chevalier. This work was translated into English by the late Mr. Cobden. It appears, however, that, although the evils of a double currency exist and are very significant, the fears expressed by the author are exaggerated. It is almost impossible to decide on abstract grounds which of the two precious metals is the fittest for a standard of value. Neither seems to possess so marked an advantage over the other as to suggest the abandonment of that metal which has been hitherto habitually used. In this country it needs not to be observed that gold is the standard, silver being purposely over-valued by $6\frac{14}{11}$ per cent. and limited as a legal tender to amounts of forty shillings and under; while copper is over-valued by 50 to 70 per cent. and similarly limited to payments of twelve pence. These regulations were established at the restoration of cash payments, 56 Geo. III. c. 68.

No seignorage or duty has been levied in this country on the legal standard, since the commencement of the seventeenth century. There is no necessary objection to a slight duty on coined money, the weight of the coin being reduced by the amount of the duty. A coin is a manufactured article, manufactured indeed for obvious reasons by government, but, by reason of the labour employed upon it, a more valuable commodity than an unstamped and uncertified piece of bullion. Hence as a sovereign is of exactly the same value as its weight in gold of the same fineness, there is nothing to prevent the melting of coin, for purposes of exportation, beyond the trouble of fusion. As, however, in effect, English sovereigns circulate in many parts of the Continent, and are even received as legal tender, it may be doubted whether the melting of English gold coins is carried on to any notable extent. A seignorage, however, is virtually levied on the silver and copper currency, and amounts to so considerable a sum as to defray the ordinary expenses of the Mint. But a seignorage on gold coins is levied in France, and the weight of the napoleon is reduced by an equal amount below its nominal value. Hence the French gold currency does not, like the English, answer all the purposes of bullion in a manufactured and certified form.

Since the reformation of the currency in 1816, the statutes prohibiting the export and import of gold and silver coins have been repealed, and transactions in the currency of this and other countries are not only permitted but unregistered. The only possible inconvenience which might be supposed to ensue from the abolition of these restrictions is contained in the supposed ignorance of the amount of specie imported into the country. But even if knowledge on this subject were of any great importance, it is supplied indirectly by the fact, that owing to the perfection of our banking institutions, the greatest amount of all imported specie passes through the bank of England, and is by means of this institution distributed over the world. It is of great, indeed of vital importance, to the monetary system of the country, that accurate knowledge should be possessed of the amount of specie held by the great centre of English commerce, the bank of England; but unless the public were also acquainted with the amount of specie held by the general community, the mere facts of the import and export of bullion could have little more than a scientific or speculative value. It is enough to know the causes which determine the influx and efflux of bullion.

Notice has been already taken of the substitution of metallic currency or money proper under the head Currency, to which the reader may be referred. Care, however, must be

taken to distinguish bank paper convertible at the pleasure of the holder, from paper money in the sense of an inconvertible paper issued at the pleasure of government, and not exchanged at the pleasure of the holder into specie. The effects of the latter form of paper substitute are analogous to those which ensue from an issue of a debased metallic currency; with this difference, indeed, that unless the inconvertible paper, so issued, descends, as it too frequently does, to notes of low denomination, the parties who are made subject to the effect of such a paper are better able to understand the depreciation of the security, and to bear the loss. When, however, the metallic currency is debased, the loss for the most part falls on those who live by wages, whose hard earnings are mulcted by a fraudulent issue, and whose inexperience is incompetent to deal with the wrong committed.

The second table annexed to this article contains an account of moneys actually coined and still current in Europe, and in some places beyond its limits. Some change has been effected in certain German states, to be treated hereafter. Continental countries are rapidly approximating to the use of a common measure; for instance, in adopting the franc through Western Europe, and the thaler over the eastern bank of the Rhine. Such a tendency is not only natural, but highly desirable, for there can be no doubt that the operations of business would be exceedingly simplified, international communication would be made more complete, the maintenance of peace in the world would gain additional strength, and the fluctuations in the rate of exchange be reduced to the narrowest margin, if it could be possible to establish a uniform standard and a uniform currency. The barbarism, too, of a plurality of money measures in communities where commercial relations are daily becoming more intimate, is of comparatively modern origin, for some centuries ago the interpretation of rates of exchange was easy and obvious.

I. English Coins.—*Account of the English Silver and Gold Coins; showing their Value, the Seignorage or Profit upon the Coinage, and the Price of the Pound Troy of Standard Gold and Silver, from the Conquest to the Present Time.*

A. D.	Anno Regni	Silver: 1. Fineness of the Silver in the Coins (oz. dwts.)	2. Pound Weight of such Silver coined into (£ s. d.)	3. Profit or Seignorage on the Coinage (£ s. d.)	4. Equal to the Mint Price for Standard Silver of 11oz. 2dwts. fine, Troy Weight (£ s. d.)	Gold: 5. Fineness of the Gold in the Coins (crts. grs.)	6. Pound Weight of such Gold coined into (£ s. d.)	7. Profit or Seignorage on the Coinage (£ s. d.)	8. Equal to the Mint Price for Standard Gold of 22 Carats fine, Troy Weight (£ s. d.)
1066	Conquest . .	11 2	1 0 0						
1280	8 Edward I. .	— —	1 0 0	0 1 0	1 0 3½				
1300	28 " " .	— —	1 0 3	0 1 2¼					
1344	18 Edward III.	— —	1 0 3	0 1 3	1 0 3½	23 3½	13 3 4	0 8 4	12 10 8
1349	23 " " .	— —	1 2 6	0 1 3	1 2 8	— —	14 0 0	0 11 8	13 3 9
1356	30 " " .	— —	1 5 0	0 0 10	1 5 9½	— —	15 0 0	0 6 8	14 8 4
1394	18 Richard II. .	— —	1 5 0	0 0 10	1 5 9½	— —	15 0 0	0 5 0	14 9 11
1401	3 Henry IV. .	— —	1 5 0	0 0 10	1 5 9½	— —	15 0 0	0 5 0	14 9 11
1421	9 Henry V. .	— —	1 10 0	0 1 0	1 10 11¼	— —	16 13 4	0 5 0	16 2 9
1425	4 Henry VI. .	— —	1 10 0	0 1 0	1 10 11¼	— —	16 13 4	0 5 10	16 1 11
1464	4 Edward IV. .	— —	1 17 6	0 4 6	1 15 2¼	— —	20 16 8	2 10 0	18 0 5
1465	5 " " .	— —	1 17 6	0 4 6	1 15 2¼	— —	22 10 0	1 0 10	21 1 10
1470	49 Henry VI. .	— —	1 17 6	0 2 0	1 17 10¼	— —	22 10 0	0 13 0	21 9 7
1482	22 Edward IV. .	— —	1 17 6	0 1 6	1 18 4¾	— —	22 10 0	0 7 6	21 15 0
1483	1 Richard III.	— —	1 17 6	0 1 6	1 18 4¾	— —	22 10 0	0 7 6	21 15 0
1485	1 Henry VII. .	— —	1 17 6	0 1 6	1 18 4¾	— —	22 10 0	0 7 6	21 15 0
1509	1 Henry VIII.	— —	1 17 6	0 1 0	1 18 11¼	— —	22 10 0	0 2 6	22 0 0
1527	18 " " .	— —	2 0 0	0 1 0¾	1 18 11¼	— —	24 0 0	0 2 8	22 0 0
—	18 " " .	— —	2 5 0	0 1 0	2 4 0	— —	27 0 0	0 2 9	
—	18 " " .	. .	. . .	. . .	. . .	22 0	25 2 6	0 3 0	24 19 6
1543	34 " " .	10 0	2 8 0	0 8 0	2 4 4¾	23 0	28 16 0	1 4 0	26 8 0
1545	36 " " .	6 0	2 8 0	2 0 0	2 11 9½	22 0	30 0 0	2 10 0	27 10 0
1546	37 " " .	4 0	2 8 0	4 4 0	2 15 6	20 0	30 0 0	5 0 0	27 10 0
1547	1 Edward VI. .	4 0	2 8 0	4 4 0	2 15 6	20 0	30 0 0	1 10 0	31 7 0
1549	3 " " .	6 0	3 12 0	4 0 0	2 19 2½	22 0	34 0 0	1 0 0	33 0 0
1551	5 " " .	3 0	3 12 0						
—	5 " " .	11 0	3 0 0	. . .	. . .	23 3½	36 0 0		
—	5 " " .	. .	. . .	. . .	. . .	22 0	33 0 0		
1552	6 " " .	11 1	3 0 0	0 1 0	2 19 8½	23 3½	36 0 0	0 2 9	
—	6 " " .	. .	. . .	. . .	. . .	22 0	33 0 0	0 3 0	32 17 8
1553	1 Mary . .	11 0	3 0 0	0 1 0	2 19 6½	23 3½	36 0 0	6 3 0	33 0 8
1560	2 Elizabeth .	11 2	3 0 0	0 1 6	2 18 6	23 3½	36 0 0	0 5 0	
—	2 " " .	. .	. . .	. . .	. . .	22 0	33 0 0	0 4 0	32 16 0
1600	43 " " .	— —	3 2 0	0 2 0	3 0 0	23 3½	36 10 0	0 10 0	
—	43 " " .	. .	. . .	. . .	. . .	22 0	33 10 0	0 10 0	33 0 0
1604	2 James I. .	— —	3 2 0	0 2 6	2 19 6	22 0	37 4 0	1 10 0	35 14 0
1626	2 Charles I. .	— —	3 2 0	0 2 0	3 0 0	— —	41 0 0	1 1 5	39 18 7
1666	18 Charles II. .	— —	3 2 0	0 0 0	3 2 0	— —	44 10 0	. . .	44 10 0
1717	3 George I. .	— —	3 2 0	0 0 0	3 2 0	— —	46 14 6	. . .	46 14 6
1816	56 George III. .	— —	3 6 0	0 4 0	. . .	— —	46 14 6	. . .	46 14 6

II. *Account of the Contents or Weight, and of the Value in Sterling, of the Principal Gold Coins of different Countries.*

Coins	Contents in pure Gold	Value in Sterling	
	grs.	s.	d.
AUSTRIAN DOMINIONS:			
Souverain	78·6	13	10·92
Double ducat	106·4	18	9·97
BAVARIA:			
Max d'or, or Maximilian . .	77·	13	7·44
Ducat	52·8	9	4·12
COLOGNE:			
Ducat	52·6	9	3·70
DENMARK:			
Christian d'or	93·3	16	6·14
ENGLAND:			
Sovereign	113·1	20	0·
Half-sovereign	56·55	0	10·
FRANCE:			
Napoleon, or piece of 20 francs	89·7	15	10·5
HAMBURG:			
Ducat (double in proportion) .	52·9	9	4·35
HANOVER:			
George d'or	92·6	16	4·66
Ducat	53·3	9	5·19
HOLLAND:			
Ducat	52·8	9	4·13
MALTA:			
Louis	108·	19	1·37
MILAN:			
Sequin	53·2	9	4·98
Doppia or pistole	88·4	15	7·74
40 lire piece of 1808 . . .	179·7	13	9·64
NAPLES:			
6 ducat piece of 1783 . .	121·9	21	6·89
3 ducat piece, or oncetta, of 1818	58·1	10	3·40
NETHERLANDS:			
Gold Lion, or 14 florin piece .	117·1	20	8·69
10 florin piece, 1820 . . .	93·2	16	5·93
PORTUGAL:			
Dobraon of 24,000 rees . .	759·	134	6·96
Dobra of 12,800 rees . . .	401·5	71	0·70
Moidore or Lisbonnine (½, &c., in proportion) . . .	152·3	26	11·24
PRUSSIA:			
Frederick (double) of 1800 .	184·5	32	7·34
Frederick (single) of 1800 .	92·2	16	3·42
ROME:			
Scudo	367·	64	11·43
RUSSIA:			
Ducat	53·2	9	4·98
Imperial	181·9	32	2·31
SARDINIA:			
Carlino (½ in proportion) .	219·8	30	8·10
SAXONY:			
Ducat	52·9	9	4·34
SPAIN:			
Pistole	90·1	15	11·85
SWEDEN:			
Ducat	51·9	9	2·23
SWITZERLAND:			
Pistole	105·9	18	8·91
TUSCANY:			
Zecchino or sequin . . .	53·6	9	5·83
UNITED STATES:			
Eagle (½ and ¼ in proportion) .	246·1	43	6·66
VENICE:			
Zecchino or sequin (½ and ¼ in proportion)	53·6	9	5·83
EAST INDIES:			
Mohur of 1770	186·8	33	0·72
Mohur, half, 1787 (¼ in prop.)	94·	16	7·64
Mohur sicca of Bengal . .	189·8	30	1·04
Rupee, Bombay, 1818 . .	164·7	29	1·78
Rupee of Madras, 1818 . .	165·	29	2·42
Pagoda star	41·8	7	4·77

III. *Account of the Contents of Weight, and of the Value in British Standard Silver at 5s. 2d. an Ounce, of the Principal Silver Coins of different Countries.*

Coins	Contents in pure Silver	Value in Sterling	
	grs.	s.	d.
AUSTRIA:			
Rix dollar, or florin, *Convention*	179·6	2	1·07
Copftsuck, or 20 kreutzer piece	59·4	0	8·29
Halbe copf, or 10 kreutzer piece	28·8	0	4·01
BADEN:			
Rixdollar	358·1	4	2·
BAVARIA:			
Rixdollar of 1800 (½ in proportion)	345·6	4	0·25
Copftsuck	59·4	0	8·29
BRUNSWICK:			
Rixdollar, *Convention* . .	359·2	4	2·15
Half-rixdollar	179·6	2	1·07
DENMARK:			
Rykedaler	388·4	4	6·23
Half-rykedaler	194 2	2	3·11
Mark, specie, or ⅙ rykedaler .	64·4	0	7·59
ENGLAND:			
Crown (*old*)	429·7	5	0·
Half-crown	214·8	2	6·
Shilling	85·9	1	0·
Sixpence	42·9	0	6·
Crown (*new*)	403·6	4	8·36
Half-crown	201·8	2	4·18
Shilling	80·7	0	11·27
Sixpence	40·3	0	5·63
FRANCE:			
Franc	69·4	0	9·69
Demi-franc	34·7	0	4·84
GENOA:			
Scudo, of 8 lire	457·4	5	3·87
HAMBURG:			
Rixdollar, specie	397·5	4	7·49
Double mark, or 32 schilling piece (single in proportion) .	210·3	2	5·36
Piece of 8 schillings . . .	50·1	0	6·99
HANOVER:			
Rixdollar, *Constitution* . .	400·3	4	7·89
Florin or piece of ⅔, fine .	200·3	2	3·96
HOLLAND:			
Florin or guilder (½ in prop.) .	146·3	1	8·49
12 stiver piece	93·4	1	0·90
Florin of Batavia . . .	141·6	1	7·77
LUBECK:			
Rixdollar, specie . . .	391·9	4	6·73
Mark	105·1	1	2·67
LUCCA:			
Scudo	372·3	4	3·96
MALTA:			
Ounce of 30 tari of Emmanuel Pinto	337·4	3	11·11
2 tari piece	17·7	0	2·41
MILAN:			
Scudo of 6 lire (½ in prop.) .	319·6	3	8·62
Lira	52·8	0	7·37
MODENA:			
Scudo	387·4	5	4·13
NAPLES:			
Ducat new (½ in proportion) .	295·4	3	5·24
Piece of 10 Carlini . . .	295·1	3	5·20
NETHERLANDS:			
Florin	148·4	1	8·72
Half-florin (with divisions in proportion)	75·	0	10·46
POLAND:			
Florin, or gulden . . .	84·	0	11·72
PORTUGAL:			
New crusado, 1809 . . .	198·2	2	4·67
Seis vintems, or piece of 120 rees	46·6	0	6·50
Testoon	42·5	0	5·93
Tres vintems, or piece of 60 rees, 1802	23·3	0	3·25
Half-testoon, 1802 . . .	20·4	0	2·84
PORTUGUESE COLONIES:			
Piece of 8 macutes, of Portuguese Africa	159·3	1	10·31
Ditto of 4 ditto	78·1	0	10·90

Coins	Contents in pure Silver	Value in Sterling
PRUSSIA:	grs.	s. d.
Rixdollar, *Convention*	359·	4 2·13
Florin, or piece of ⅓	196·4	2 3·70
ROME:		
Scudo, or crown	371·5	4 3·87
Mezzo-scudo, or half-crown	185·7	2 1·93
Paolo	37·2	0 5·19
RUSSIA:		
Rouble	312·1	3 7·58
Rouble of Alexander, 1805	278·1	3 2·83
20 copeck piece, 1767	62·6	0 8·74
5 copeck piece	15·3	0 2·13
SARDINIA:		
Scudo, or crown (½ and ¼ in prop.)	324·7	3 9·34
SAXONY:		
Rixdollar, *Convention* (½ and ¼ in proportion)	358·2	4 2·01
SICILY:		
Scudo (½ in proportion)	348·2	4 0·62
SPAIN:		
Dollar, of late coinage	370·9	4 3·79
Half-dollar, ditto	185·4	2 1·88
SWEDEN:		
Rixdollar	388·5	4 6·28

Coins	Contents in pure Silver	Value in Sterling
SWITZERLAND:	grs.	s. d.
Ecu of 4 franken	407·6	4 9·16
TURKEY:		
Piastre, 1818	67·7	0 9·45
TUSCANY:		
Lira	53·4	0 7·45
UNITED STATES:		
Dollar	370·1	4 3·68
WIRTEMBERG:		
Rixdollar, specie	559·1	4 2·14
Copftsuck	59·8	0 8·35
EAST INDIES:		
Rupee sicca, coined by the East India Company at Calcutta	175·8	2 0·54
Calcutta, 1818	175·9	2 0·56
Bombay, new, or Surat, 1818	164·7	1 11·01
Company's rupee, 1835	165·	1 11·
Fanam, Cananore	32·9	0 4·5
Bombay, old	35·	0 4·88
Pondicherry	22·8	0 3·18
Ditto, double	39·	0 5·44
Gulden of the Dutch East India Company, 1820	148·4	1 8·72

For the changes introduced into the German Union, see ZOLLVEREIN.

The following tables of ancient moneys are extracted from the essay of the Rev. Robert Hussey, M.A., sometime Professor of Ecclesiastical History in the University of Oxford, the latest and most accurate authority on the subject:—

I. *Attic Standard.*

												£	s.	d.	q.
Chalcus (of Copper)															·8125
2	½	Obolus													1·625
4	2	½	Obolus												3·25
8	4	2	Obolus											1	2·5
16	8	4	2	Diobolus										3	1
24	12	6	3	1½	Triobolus									4	3·5
32	16	8	4	2	1⅓	Tetrobolus								6	2
48	24	12	6	3	2	1½	Drachma							9	3
			12	6	4	3	2	Didrachma					1	7	2
			24	12	8	6	4	2	Tetradrachma				3	3	
			600	300	200	150	100	50	25	Mina		4	1	3	
			3,600	18,000	12,000	9,000	6,000	3,000	1,500	60	Talent	243	15		

II. *Æginetan Standard.*

						Weight in grs.	Value s. d. q.
½	Obolus					8	1 0·583
	2	Obolus				16	2 1·166
	4	2	Diobolus			32	4 2·33
	6	1	1½	Triobolus		48	6 2·5
	12	6	3	2	Drachma	96	1 1 3
	24	12	6	4	2 Didrachma	192	2 3 2

III. *Roman Money up to Augustus.*

									Copper. d. q.
Sextula									·35416
1½	Quadrans								·53125
2	1⅓	Triens							·7083
3	2	1½	Semissis						1·0625
6	4	3	2	As					2·125
12	8	6	4	2	Dupondius				1 ·25
24	16	12	8	4	2	Sestertius			2 ·5
48	32	24	16	8	4	2	Quinarius		4 ·1
96	64	48	32	16	8	4	2	Denarius	8 ·2

IV. *Silver.*

						d.	q.
					Torunculus		·53125
2					Sembella		1·0625
4	2				Libella		2·125
16	8	4			Sestertius	2	·5
32	8	4	2		Quinarius	4	·1
64	16	8	4	2	Denarius	8	·2

Gold.

	£	s.	d.
Denarii 12½ Half Aureus		8	10½
25 Aureus		17	8½
Mille Nummi = Sestertium	8	17	1

V. *Roman Money after Augustus.*

									s.	d.	q.
								Sextula			·3125
1½								Quadrans			·46875
2	1⅓							Triens			·625
3	2	1½						Semissis			·9375
6	4	3	2					As			1·875
12	8	6	4	2				Dupondius			3·75
24	16	12	8	4	2			Sestertius		1	3·5
48	32	24	16	8	4	2		Quinarius		3	·3
96	64	48	32	16	8	4	2	Denarius		7	·2
								Aureus = 25 Denarii	15	7	·2

Mille Nummi = £7 16*s.* 3*d.*

VI. *Hebrew Money.*

						£	s.	d.	q.
					Gerah			1	2·27
5					Reba			7	3·36
10	2				Beka		1	3	2·72
20	4	2			Shekel		2	7	1·49
1,200	240	120	60		Maneh	7	16	10	·3
60,000	12,000	6,000	3,000	50	Kikkar, or Talent	396	5	10	

Of the money mentioned in the Gospels: *q.*
Lepton or Mite . . . = 0·244
2 Lepta = 1 Quadrans, or farthing = 0·488

Moneyers, Company of. Certain officers of the Mint were thus designated, under whose superintendence and responsibility the various moneys of the realm were manufactured. In the year 1837 the government contracts with this company ceased, and their duties were transferred to other officers under the more immediate appointment of the Master of the Mint. The details of these changes, and of the duties of the moneyers as contractors for the manufacture of the money of the realm, will be found in the Parliamentary Reports relating to the Mint, published in 1837. [MINT.]

Mongolfier Balloon. A balloon filled with atmospheric air considerably dilated by heat, so called from its inventor. A fire-balloon.

Moniliform (Lat. monile, *a necklace*). A Botanical term: it is applied to the pod of the *Hedysarum moniliferum*, from its necklace-like appearance.

Monimiaceæ (Monimia, one of the genera). An order of diclinous Exogens, of the Menispermal alliance, consisting of aromatic trees or shrubs, with opposite leaves. They are found mostly in the forests of South America. The order is distinguished by its perigynous stamens, its pendulous seeds, and its small embryo on the outside of copious fleshy albumen.

Monizia (after M. Moniz, a botanist of Madeira). A subarborescent genus of *Umbelliferæ* found on the island of Deserta Grande, one of the Madeira group, where it is called the *Carrot-tree.* It has a crooked woody stem, one to four feet high, gouty at the base, terminating in a tuft of decompound broadly triangular fern-like leaves one to three feet long, and small white flowers disposed in compound many-rayed umbels. The orchil-gatherers and fishermen, who resort to the island, eat the roots when prevented by weather from getting better food. These roots have long curved horn-like divisions, black outside, farinaceous and white within, and much more fibrous than those of a carrot.

Monkeypot. A name given to the woody pericarp of *Lecythis ollaria.*

Monkshood. The *Aconitum Napellus* of botanists. [ACONITE.]

Monocarpous (Gr. μόνος, *single*; καρπός, *fruit*). In Botany, a term invented by De Candolle to designate what gardeners call annual plants, and a few others which, like the American aloe, although they may live for many years, yet perish as soon as they have once borne fruit.

Monochlamydeous (Gr. μόνος; χλαμύς, *a cloak*). In Botany, applied to those plants which have but one floral envelope.

Monochord (Gr. μονόχορδος, *with one string*). In Music, an instrument consisting of a single string stretched between two bridges standing on a graduated rule, for the purpose of measuring the variety and proportion of musical sounds. The monochord is called the *harmonical canon*, or the canonical rule.

Monochromatic Lamp. When a solution of common salt is added to spirit of wine, the mixture burns with a flame in which yellow predominates almost to the exclusion of the other coloured rays; the consequence is, that objects viewed by this light are all either yellow or black, and deficient in the tints which they exhibit when seen by solar light, or by that of our ordinary combustibles. (Sir David Brewster, *Family Library*, on 'Natural Magic.')

Monochrome (Gr. μονόχρωμος, *of one colour*). A painting executed in a single colour, but relieved by light and shade. A drawing in chiaro-scuro is a monochrome, whether in black and white or in any colour and white.

Many of the ancient painters were monochromists, as for instance Zeuxis: the skiagram or silhouette is not a monochrome, though executed in a single colour. [PAINTING.]

Monocotyledons (Gr. μόνος, and κοτυληδών, *a cavity*). A class of plants having but one cotyledon or seed-lobe in the embryo. They are now more generally called ENDOGENS [which see].

Monodelphs (Gr. μόνος, and δελφύς, *a womb*). A name given by De Blainville to the first sub-class in his binary division of Mammalia, comprehending those which have no supplementary external pouch or marsupium, but which bring forth the young in a state sufficiently mature not to require such additional protection. It is antithetical to Didelphs.

Monodon (Gr. μονόδους, *one-toothed*). The generic name of the narwhal, signifying its supposed peculiarity of having but one tooth, which projects like a horn from the fore-part of the head; a second tooth, however, is always to be found concealed in the adjoining jaw, where it remains in a rudimental state. In the female both tusks are rudimental.

Monody (Gr. μονῳδία, *a solo*). A species of poem of a mournful character, in which a single mourner is supposed to bewail himself: thus distinguished from those pastoral elegies (like the *Daphnis* of Virgil) which are in the form of dialogues.

Monœcia (Gr. μόνος; οἶκος, *a house*). In Botany, the twenty-first class in the system of Linnæus, comprising the Androgynous plants, or those whose structure is both male and female. Thus *monœcious* means having both male and female flowers on the same plant, but separate.

Monogenesis (Gr. μόνος; γένεσις, *birth*). Professor van Beneden understands this term as applied to the direct developement e. g. of an Entozoon from a parent resembling itself. Prof. A. Thomson uses it as applied to descent of an individual from one parent form, containing both the sperm cell and germ cell, or male and female parent principles.

Monogram (Gr. μόνος, and γράμμα, *letter*, or *writing*). An abbreviation of a name by means of a cipher composed of two or more letters intertwined with each other. Monograms were used on coins in very ancient times, being found on Greek medals of the age of Philip and Alexander of Macedon. The Greek monogram of the name of Christ, which resembles P placed perpendicularly in the middle of an X, thus ☧, is found on coins of the age of Constantine. By far the greater number of the ancient monograms are still unintelligible. Among others whose researches on the ancient monograms may be consulted with advantage are: Montfaucon, *Palæographia Græca*; Froelich, *Annal. Reg. Syr.*; Combe, *Museum Hunterianum*; Torremuzza, *Description des Monnaies de Sicile*; Pellerin, *Recueil des Villes des Peuples, et des Rois*; Mionnet, *Traité de la Numismatique*. Monograms are frequently found on coins and maps of the middle ages; and they are also to be met with as a substitute for the signature of the princes of that period. This class of monograms is of great importance, and their investigation constitutes a distinct and peculiar branch of diplomatics. In later times monograms were frequently employed by printers and engravers to record their names at the end or on the title-page of a book, or in some portion of an engraving. The Abbé de Marolles, in 1667, was the first who directed attention to this branch of the subject; and to him succeeded Florent Lecomte (*Cabinet des Singularités d'Architecture, &c.*); Orlandi (*Abecedario Pittorico*); Fr. Chrüt (*Anzeige und Auslegung der Monogrammatum*); De Virloy (*Dictionnaire d'Architecture*); and Bartsch (*Peintregraveur*, a work of great accuracy and research). But the most complete and accurate information on this class of monograms is to be found in the editio optima of Brulliot (*Dictionnaire des Monogrammes, &c., avec lesquels les Peintres, &c., ont designé leurs Noms*, 2 tom. 4to. Munich 1832; a work founded on the principle of considering the *first* letter of the monogram as the key to its explanation).

Monograph (Gr. μόνος, and γράφω, *I write*). A treatise or memoir on a single subject, as, for example, the greater part of the memoirs which are read before learned societies.

Monogynia (Gr. μόνος, and γυνή, *a female*). In Botany, the name given by Linnæus in his system to the first order or subdivision in each of the first thirteen classes of plants, comprising such as have one pistil or stigma only in a flower. Thus *monogynous* means having but one style or stigma.

Monoid (Gr. μονοειδής, *of one form*). A name given by Prof. Cayley (*Proc. of British Association*, 1862) to a surface which possesses a conical point of the highest $(n-1)^{\text{th}}$ possible order. Such a surface is represented by the equation $Q\omega = P$, where P and Q are homogeneous functions of x, y, z of the orders n and $n-1$ respectively, and $\omega = 0$ is the equation of a plane. The origin is the conical point, or *vertex*. The cones P and Q are called respectively the *superior* and *inferior cones of the monoid*. Such surfaces are of use in the investigation and representation of curves in space. The hyperboloid of one sheet is a familiar instance of a monoid.

Monolith (Gr. μονόλιθος, *of one stone*). A term recently introduced into England, to signify a pillar consisting of a single stone. Herodotus speaks of a huge rock of this sort in front of a temple at Sais, which was scooped out, and contained an apartment eighteen cubits in length, twelve in breadth, and five in height. It was said to have been transported from the town of Elephantine by order of king Amasis, and to have occupied 3,000 men for three years in conveying it. Some remarkable monoliths have been found in Egypt; of these the zodiac of Denderah, and the obelisk

of Luxor, both of which have been removed to Paris, are well-known examples.

Monologue (Gr. μόνος, and λόγος, *a discourse*). A speech uttered by one of the dramatis personæ of a play when alone, or, as it is vulgarly termed, speaking to himself. In the drama of ancient Greece soliloquies are rare; for the passages at the commencement, or *prologues* of plays, where the first actor comes forward and explains his own character and something of the subject of the piece to the audience, can hardly be termed soliloquies. The speech of Ajax before his death, in the play of *Sophocles*, is a celebrated exception.

Monomania (Gr. μόνος, and μαίνομαι, *I rage*). Insanity upon one particular subject, the mind being in an apparently sound state in reference to other matters.

Monome or **Monomial** (Gr. μόνος, and νόμος, *a portion*). In Algebra, an expression consisting of a single term. It may or may not contain more than one factor. Thus a, $2ab$, $3acx^2$ are monomials.

Monomerans (Gr. μόνος, and μηρός, *a limb*). A section of Coleopterous insects, including those in which the tarsi were supposed to be formed of a single joint.

Monomyaries (Gr. μόνος, and μυών, *muscle*). Bivalves or conchifers, which have only one adductor muscle, and consequently but one muscular impression on each valve.

Mononeurans (Gr. μόνος, and νεῦρον, *nerve*). A term applied by Rudolphi to the series or primary division comprehending the animals which he believed to have only the ganglionic system of nerves, as the molluscs and insects.

Monopetalous (Gr. μόνος, and πέταλον, *a petal*). In Botany, a term applied to a corolla the petals of which cohere by their contiguous margins, so as to form a tube.

Monophyllous (Gr. μονόφυλλος, *one-leaved*). In Botany, a term applied to a calyx the sepals of which cohere by their contiguous edges into a kind of tube or cup. It also denotes anything which has only one leaf.

Monophyodonts (Gr. μόνος; φύω, *I generate*; ὀδούς, *tooth*). In Zoology, those mammals which generate one set of teeth, as e.g. the sloths, armadillos, orycteropus, ornithorhynchus, and the true cetacea; all other mammals that have teeth generate two sets, called *deciduous* and *permanent*.

Monophysites (Gr. μονοφυσῖται, from μόνος, and φύσις, *nature*). A name given in the fifth century to certain heretics who, in the language of the Athanasian creed, 'confounded the substance,' that is, the divine and human substance, which are united in Christ, but neither absorbed into the other. [INCARNATION; EUTYCHIANS; NESTORIANS.]

Monopleurobranchians (Gr. μονόπλευρος, *with one side*, and βράγχια, *gills*). A name given by De Blainville to an order of his class *Paracephalophora*, comprehending those species which leave the branchiæ more or less completely covered by a part of the mantle, and situated on the right side of the body.

Monopoly (Gr. μονοπωλία, from μόνος, *alone*, and πωλέω, *I sell*). In the history of English commerce, we shall find that the natural freedom of trade has been greatly interfered with by regulations which, originally enacted as measures of police, or for public defence, have been made, as a portion of the royal or parliamentary prerogative, a source of income to the crown, or of pecuniary advantage to the favourites of a dominant party in the legislature. It is clear that there is a natural right to free exchange, and that any interference with the fundamental privilege of individual action (that, namely, of disposing according to the best of a man's discretion of his personal labour or its products) can be defended only on those grounds of public policy which on any interpretation of the theory of government must override private interest or convenience, in cases where the latter is wholly irreconcilable with the former. It is hardly necessary to observe, that such a clashing of interests is very rarely of other than obvious solution.

In early times the police exercised over craftsmen and traders in towns, and by implication over the apprenticeship of the former and the registration of the latter in a guild or fraternity, stood in the place of that modern method of municipal government which is not less effective than the ancient régime, and far less obstructive in its incidence. The apprenticeship of the artisan and the registration of the trader was a pledge of good conduct, and as the privilege in either case was to some extent a reversal of the feudal system of dependence, the aid of the crown was invoked in order to create and confirm the privileges of the borough towns. As a natural consequence, the right of sole labour and sole sale, which the town achieved as a protection from feudal lords, and the crown sustained as a barrier against feudal insolence or independence, degenerated, when the motive for the institution was abolished, into a narrow monopoly on the one side, and a lucrative prerogative on the other. The first age of monopoly was the monopoly of chartered towns, and their analogues, the great privileged markets or fairs.

This ancient prerogative of the crown was after the Reformation, when society was wholly revolutionised, exercised in favour of individuals. Towards the close of Elizabeth's reign, the grant of monopolies to private traders had become so general, and withal so intolerable, as to provoke angry comments in the House of Commons, where in particular one of the members enquired whether bread had not been made subject to monopoly. These private monopolies were declared illegal at the conclusion of the reign of James I. But in the end the powers claimed by the crown were usurped by parliament.

Charters conferring special rights and sole privileges of trade on companies have their beginning at about the same date with private

monopolies, but after the Revolution they were conferred in important cases very freely by parliament. There was indeed this defence for the action of the legislature, that some of these corporations of traders, as, for instance, the Bank of England and the South Sea Company, did considerable public service in negotiating loans, and in securing lower terms for the ______ of public stock than could perhaps have been procured by general subscription. But, as we have learnt since the privileges of these great companies have been invaded or annulled, the effect of the restriction has been exceedingly detrimental to the growth of public wealth. Had not the monopoly of the bank of England been invaded, the benefits of joint-stock banking could not possibly have been afforded to the community; and, still more markedly, if the sole privilege of trade in the East, secured by its older charters to the East India Company, had not been annulled, the vast and flourishing commerce with the regions lying beyond the Cape would have been represented by the languid and unprofitable transactions of the incorporated merchants of Leadenhall Street. All the energy which is now peopling Australasia with the Anglo-Saxon race, would have been lost or rendered abortive if the old monopoly of the Company had been retained.

A fourth phase of monopoly was that which characterised the colonial system. In order to secure the fancied benefits of a sole trade, the government of this country, in return for a rigid system of an exclusive market for its own produce, secured the colonists the questionable boon of imperial protection, and reciprocated their own exclusive right of traffic by prohibiting or visiting with enormous duties the importation of raw produce from independent states, provided the same commodities formed a part of colonial industry. Hence the differential duties on sugar, coffee, timber, &c. It is manifest that under such circumstances the colony and the mother country were equally losers. Both paid higher prices, or, what is the same thing, expended more labour for inferior articles. The merit of refuting theoretically the absurdities of the colonial system must be assigned to Adam Smith; the practical explosion of the reciprocity scheme was found in the immense impulse given to trade by the independence of the American plantations, notwithstanding the gloomy predictions of commercial men with which the commencement of that epoch was accompanied.

In modern language, the term *monopoly* is used somewhat loosely for such special advantages as are assigned or supposed to be assigned to particular interests in the community, and which are held up to odium under the name of class legislation. This is not the place in which any discussion on the nature or the number of such privileges can be fitly introduced; but in general it may be laid down as an economical axiom, that every invasion of absolute freedom in acts of exchange is perpetually open to assault, and can only be defended on the highest grounds of public policy; and that it is equally certain, that the advantage given to particular interests is only apparent, and tends by a just law of retribution to the ultimate injury of the favoured class, just as it is assuredly an inexcusable wrong to the general public.

Monopolylogue (Gr. μόνος; πολύς, *many*; and λόγος, *a discourse*). A term recently invented to designate an entertainment in which a single actor sustains many characters.

Monopteral (Gr. μονόπτερον, *with but one wing*). In Architecture, a temple, or circular enclosure of columns, without a cell.

Monorhyme. A composition in verse, in which all the lines end with the same rhyme. This species of composition is said to owe its invention to Benin, who wrote in Latin, and dedicated his monorhymes to Pope Alexander III.

Monosepalous. In Botany, having the sepals all united into one body by their edges.

Monostoma (Gr. μονόστομος, *with one mouth*). The name of a genus of Trematode Entozoa, including those which have only a single pore, serving at once for nutrition and adhesion.

Monothalamans (Gr. μόνος, and θάλαμος, *a chamber*). This term is applied to those univalve shells which have only one chamber.

Monotheism (Gr. μόνος, and Θεός, *God*). The belief in the existence of one God, in contradistinction to polytheism, the belief in many gods. The attempt to ascertain the extent or the origin of such a belief must carry us into an examination not only of historical and other documents, but also of human language. If it be the fact that all names or words which now bear an abstruse signification 'had their first rise from sensible ideas,' that words which now denote the Divine Spirit meant originally nothing more than the breath of the sky; if it be true, as Professor Max Müller holds, that the establishment of human relationships succeeded the dawn of a knowledge of numbers, and preceded the conception of a Creator, a Ruler, and Father of men, it would follow that the conviction of the existence of one God was the result not of an intuition but of a gradual education. The question cannot be satisfactorily settled on the ground of authority; for even if it be granted that the third chapter of the Book of Genesis sets forth unmistakably a religion in which the doctrine of the Unity and supremacy of the Godhead was united with that of a coequal and coeternal Trinity, we cannot by reference to such a record account for the growth or decay of monotheistic belief in nations cut off from all intercourse with the Semitic race. If it be maintained that the Hellenic Zeus is a corruption of the Supreme God originally revealed (Gladstone, *Homer and the Homeric Age* ii. 43 &c.), we are met by the difficulty that that which is so perverted cannot become clearer and more definite in the very process of corrupt developement. On such a supposition not only must the positive truths imparted at first undergo distortion, but the

ideas involved in them must become weaker and weaker; and thus the personality and power of Zeus would be more distinct and real in the earliest times than in the later, which appears not to have been the case. But if we take the earlier Vedic writings as exhibiting the most primitive workings of the human mind with which we are acquainted, it would seem that the consciousness of their own existence led men to attribute life to every object. This life was not necessarily personal, for they had scarcely reached the distinction between consciousness and personality; it was simply confined to consciousness; and every object became a living reality, and every word a speaking picture. Hence arose the mythical speech which described the daily and annual course of the sun [MYTHOLOGY], the succession of summer and winter, and the phenomena of clouds, lightning, earthquake and storms. In all this there was, it seems, no personification, and still less was there any allegory or metaphor; but while such language expressed a sentiment and a belief, it was hot strictly a religion. This first condition of thought, which regarded every object in creation as endowed with life, could have *in itself* only two possible developements. It must issue either in an anthropomorphous polytheism, or a degrading fetish worship; in other words, into a multiplication of deities with human forms and passions, or into an abject terror of inanimate things. The former result is exhibited in the mythological system of the Greeks and Latins; but it cannot perhaps be said with truth that this mythology determined the convictions of any who deserved the name of thinkers. All prayed to Zeus; but if the Homeric poems speak of a Zeus who has many earthly loves and is at once arbitrary and sensual, it is equally certain that Achilles does not pray to a lying god who owns no law for himself and cannot be a law for man. If the Hesiodic poets ascribe to the gods horrible banquets, to which Pindar and Plato refused to give credence, the same poets bid all men to follow after justice, because the gods spend their time not in feasting, but in watching the ways and works of men. In short, an examination of the Hesiodic writings seems to establish the position that the grossness and elaborateness of a mythological system is not necessarily a measure or a test of the real religious convictions of a people, or at all events of the thinking portion of a people. Thus, while familiarly handling these mythical tales, Sophocles (*Od. Tyr.* 863) could speak unequivocally of a purity in word and deed which has its birth not on earth but in heaven, and of which the imperishable law is realised in a god as holy and everlasting. The case of the Jewish people is closely parallel; for while the prophets exhibit a sure and steadfast trust in one God who is the Father and Judge of all men, yet their constant remonstrances are sufficient evidence that the great body of the people could scarcely be characterised by any other name than that of polytheists down at least to the time of the Babylonish captivity. But a further light is thrown on the subject, if we examine those earlier Vedic writings which form 'the oldest book in existence,' irrespectively of their age, for, in Prof. Max Müller's words, 'If this collection had been written but fifty years ago, in some distant part of the world untouched by the general stream of human civilisation, we should still call it more ancient than the Homeric poems, because it represents an earlier phase of human thought and feeling.' These writings exhibit with singular clearness and force the growth or the influence of a monotheistic belief. For many striking illustrations we must refer the reader to Professor Max Müller's *History of Sanskrit Literature*, ch. iv. But we may quote his remark that, long before the Hindus 'began to care for the laws of nature, the return of the seasons, the course of the stars, or any other scientific or practical subject, their thoughts were fixed on the one great and ever recurring question, What am I? What does all this world around me mean? Is there a cause, is there a Creator—a God? or is it all illusion, chance, and fate?' Yet, even while the poet admits that 'he knows not what this is that he is like, and that he walks turned inward, chained in his mind,' he adds, 'when the first born of time comes near me, then I obtain the portion of this speech.' In the same hymn in which these words occur there is one verse which explicitly declares the existence of but One Divine Being, invoked under different names. 'They call (him) Indra, Mitra, Varuna, Agni; then he is the well-winged heavenly Garutmat; that which is One, the wise call it many ways; they call it Agni, Yama, Mâtarisvan.' In another hymn, the poet, asking repeatedly, Who is the god to whom we shall offer our sacrifice? answers, 'He who through His power is the only King of the breathing and awakening world, He who measured out the light in the air, He who is God above all gods, the Creator of the earth, the righteous, who created the heaven, and the bright and mighty waters.' The hymns in which these passages occur cannot be assigned to any period later than the ninth century before the Christian era, many being probably very much older: it becomes unnecessary therefore to speak of the expressions of a like belief which have been found in the Orphic fragments, in words attributed to Pythagoras, and in verses said to have been sung in the Eleusinian or other mysteries.

Monothelites (Gr. *μονοθελῆται*, from *μόνος*, and *θέλω*, *I will*). A sect of heretics, who, while they avoided the error of the Eutychians, and allowed the two natures of Christ to coexist distinctly in the unity of the person, conceived the influence of the divine will so to predominate over the human substance as to leave to the latter no action or efficiency of its own.

The origin of this doctrine is ascribed to the emperor Heraclius, who, in the year 630, at

tempted to reconcile the Eutychians or Monophysites to the Catholic church by a middle course of this nature, and published an edict, under the advice of some theologians of the day, in assertion of it. This opinion was condemned by some provincial councils and one general council; and, on the other hand, was maintained by the edict of several succeeding emperors. Nor was the question finally settled, though silence was frequently commanded upon it, until it was forgotten in the louder disputes of the Iconoclasts and their opponents.

Monotremes (Gr. μόνος, and τρῆμα, *a hole*). A tribe of ovo-viviparous Mammalia, of which only two genera are known to exist; viz. the *Platypus* or *Ornithorhynchus*, and the *Echidna*, both peculiar to Australia. The term is indicative of the common cloacal outlet for the excremental and generative products.

Monotriglyph. In Architecture, such an intercolumniation in the Doric order as brings only one triglyph over each column.

Monotropaceæ (Monotropa, one of the genera). A small order of curious but unimportant parasitical plants, belonging to the Erical alliance of hypogynous Exogens. They have half-monopetalous flowers, free stamens all perfect, loose-skinned or winged seeds, and an embryo at the apex of the albumen. They are chiefly found in fir woods in cool latitudes in Europe, Asia, and North America.

Monradite. A hydrated silicate of magnesia and protoxide of iron from Bergen, in Norway; named after M. Monrad.

Monrolite. A variety of Kyanite from Monroe, Orange county, New York.

Monseigneur. A title of courtesy in France, which was prefixed to the titles of dukes and peers, archbishops, bishops, and some other exalted personages, and used in addressing them. *Monseigneur* simply, before the Revolution, was the title given to the dauphin. *Monsieur* is now the common title of courtesy and respect in France; and before the revolution in 1830, *Monsieur* simply was the title of the eldest brother of the king.

Monsoons (from a Malayan word signifying *seasons*). In Physical Geography, the name given to a certain modification or disturbance of the regular course of the trade winds which take place in the Arabian and Indian seas. Between the parallels of 10° and 30° south latitude the eastern trade wind blows regularly; but from the former parallel northwards the course is reversed for half the year, and from April to October the wind blows constantly from the south-west. During the other six months of the year the regular north-east trade wind prevails. The south-west monsoon is supposed to be occasioned by the great rarefaction of the atmosphere over the extensive regions of Eastern Asia during the summer months. [TRADE WINDS.]

Monster (Lat. monstrum). Anything out of the common order of nature is occasionally designated by this term; but it is physiologically employed under a more limited acceptation, and applied to animals in which one or more parts of the body present some congenital malformation. This is sometimes apparent externally, and then must amount to something exceeding any ordinary deformity; or it may be confined to internal organs. Buffon, Blumenbach, and Meckle have treated on monstrosity, classifying its modifications under three heads: the first including cases in which parts of the body are increased in number; the second those where certain organs are deficient; and the third including cases in which size, situation, and structure are concerned. Other writers, such as Geoffroy St. Hilaire (*Histoire des Anomalies*), have adopted more comprehensive arrangements; arising, however, out of the general subdivision of monsters into simple and compound; the former including all cases in which the elements of a single individual only are concerned; the latter those in which the constituent parts of two or more individuals are united. Simple monsters have again been distributed into three classes—the first including such varieties of malformation as chiefly affect one organ or system of organs, without materially interfering with any vital function: these anomalies are extremely numerous, and have been further subdivided into cases where size, form, or structure is affected, and those in which the malformation affects the arrangement, connection, or number of parts. The second class in this arrangement includes cases of extensive malformation, attended by great deformity and by disturbance of vital functions. The third class is limited to malformations of the organs of generation, including among others the various cases miscalled hermaphrodites. The history of individual cases of monstrosity would be here misplaced; several of the most remarkable are detailed in various volumes of the *Philosophical Transactions*; in the *Transactions of the Medico-Chirurgical Society*; and in the *Penny Cyclopædia*, art. 'Monster.'

Monsters or Chimerical Figures. In Heraldry, a species of bearings, of which some are very common in English coats of arms, and others common in foreign, although not often used in our own. The sagittary or centaur, man-tiger, sphinx, harpy, triton, and mermaid, are monsters compounded of the human and bestial shape. Of monstrous beasts, the most common in armorial bearings are the dragon, the griffin (a compound of the eagle and the lion), the wyvern (a two-legged dragon): besides these, there are the unicorn, the heraldic antelope, tiger, and ibex (which are chimerical figures, but representing the natural beast), the musimon (an animal between the goat and the sheep), and the salamander. Monstrous birds are the phœnix, cannet, martlet, allerion, cockatrice, &c.

Mont de Piété (Fr.; Ital. Monte di Pietà). The name given on some parts of the Continent to certain benevolent institutions, established for the purpose of lending money to the poor at a moderate rate of interest. They

originated under the papal government in the fifteenth century, and were intended to countervail the exorbitant usurious practices of the Jews, who formed at that period the great money-lenders of Europe. These institutions were afterwards introduced into many of the Continental states; and similar establishments existed, and in some cases still exist, at Paris, Madrid, Brussels, Ghent, Antwerp, &c. *Monti frumentarii* are public granaries, from which corn is sold to the necessitous Italians, on a principle somewhat analogous to that on which sums are lent by the Mont de Piété.

Montanists. Heretics of the second century, who derive their name from their founder Montanus, a Phrygian (from which circumstance they are also sometimes called Phrygians and Cataphrygians). Montanus asserted that he had received from the Holy Ghost special knowledge on points not made known to the Apostles, and aided by two enthusiastic women, named Priscilla and Maximilla, soon gathered round him a large body of followers. The most celebrated of his adherents was Tertullian. Montanus refused to communicate for ever with persons guilty of notorious crime, and held it unlawful to fly in times of persecution. He also condemned second marriages, and enjoined the observance of three Lents. The sect was subsequently divided into two branches, one following Proclus, the other being composed of the adherents of Æschines.

Montant (Fr.). In Architecture, any upright piece in a system of framing.

Monte Bolca Deposits. The older tertiary rocks of the neighbourhood of Monte Bolca, in North Italy, are so remarkable for the enormous multitude and variety of the fossil remains of fishes which they contain, as to be often specially referred to. They are chiefly muddy limestones, and it is scarcely possible to break open a slab without finding indications of these fossils. Near Mount Lebanon is a similar and almost equally rich locality of about the same geological age.

Montem. The name given to an ancient custom till lately prevalent among the scholars of Eton, which consisted in their proceeding every third year on Whit Tuesday to a tumulus (Lat. *ad montem*, whence the name), near the Bath road, and exacting money for *salt*, as it was called, from all persons present or passers by. The sum so collected was given to the *captain*, or senior scholar of the school, to assist in defraying the expenses of his residence at the university. (Huggett's *MS. Collections* for a history of Windsor and Eton Colleges, in the British Museum; and Brand's *Popular Antiquities*.)

Month (Ger. monat, Lat. mensis, Gr. μὴν, from the same root with μήνη, *moon*, Lat. mensura, Sansc. må, *to measure*). The twelfth part of our calendar year. It is so called from its being the period of the moon's revolution round the earth. [CALENDAR.]

Monticellite. A variety of Chrysolite, found in small embedded crystals at Vesuvius. Named after Monticelli, the Neapolitan mineralogist.

Montmorillonite. A rose-coloured, hydrated silicate of alumina, &c., found at Montmorillon, department of La Vienne.

Monument (Lat. monumentum). A memorial for perpetuating the remembrance of an event; also a cenotaph in memory of the dead. The productions of architecture and sculpture intended to transmit to posterity the memory of individuals and events are most generally called *monuments*. Among those in honour of individuals are tombs and sepulchral edifices or columns. The most ancient are the obelisks and pyramids of Egypt. Greece abounded with monuments of this nature. Among such buildings were the Choragic monuments, in honour of those who had received the prize as *choragi* in the theatrical and musical games; and of these the most splendid is the choragic monument of Lysicrates, vulgarly called the Lantern of Demosthenes. Among Roman monuments of this class the triumphal arches are in the first rank. The column called the Monument of London, and the Duke of York's column, illustrate respectively the definition above given.

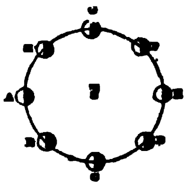
Mood (Lat. modus). In Grammar, the designation, by the form of the verb, of the manner of our conception of an event or fact, whether as certain, contingent, possible, desirable, or the like. [GRAMMAR.]

Mood of a Categorical Syllogism. In Logic, the designation of the three propositions of a syllogism in the order in which they stand, according to their quantity and quality.

Moon (Gr. μήνη, Ger. mond [MONTH]). The satellite of the earth. The moon, after the sun, is not only the most conspicuous, but, in an astronomical point of view, the most interesting of the celestial bodies. The variety of her phases, her eclipses, and the rapidity with which she changes her place among the fixed stars, drew the attention of the earliest observers of the heavens; and in modern times the important application of the theory of her motions to navigation and the determination of terrestrial longitudes, has given the *Lunar Theory* the first rank among the objects of astronomical science.

Phases of the Moon.—The different phases of the moon were probably the first celestial phenomena that received a correct explanation. By observing them attentively during the course of a single revolution, it would be inferred that they are occasioned by the reflection of the sun's light from the spherical surface of the moon; and accordingly the fact had been recognised by the earliest astronomers. Let T be the place of the earth, and A B C D E F G H successive portions of the moon in her orbit, the sun being supposed to be situated in the straight line T A, and at so great a distance that lines drawn from it to every part of the moon's orbit may be regarded as parallel. When the moon is at A, she is in *conjunction*

with the sun, and passes the meridian at the same time; and her illuminated hemisphere being then turned directly away from the earth, no portion of her disc is visible. A few days after the conjunction the moon begins to appear on the eastern side of the sun at B, having the form of a crescent, the horns of which are turned *eastward*, or away from the sun. When she arrives at C, or 90° from her conjunction, the earth is in the plane of the great circle of her orb, which forms the boundary between her dark and illuminated hemispheres, and consequently half the disc is visible. The moon is then in her *first quarter*. At D more of the illuminated hemisphere is turned towards the earth, and she appears gibbous. At E she is in opposition to the sun; the illuminated side is turned directly to the earth, and the disc appears round or *full*. After passing E the disc begins to wane, and from E to G appears gibbous. When at G, or 270° from the conjunction, she is in the *third quarter*. From this point to the conjunction the moon again appears as a crescent, becoming narrower as she approaches to A; but the horns of the crescent are now turned *westward*, still away from the sun. The straight line which joins A and E is called the line of the *syzygies*; that which joins C G is the line of the *quadratures*; and the points B D F H, situated at equal distances from those lines, are called the *octants*. The magnitude of the illuminated portion of the disc is thus seen to depend on the position of the moon relatively to the sun and the earth, and is easily determined by a geometrical construction. The mean period of time in which a revolution of the phases is completed, or in which she passes from one conjunction to the following, is 29 d. 12 h. 44 m. 2·8 s.



Distance and Magnitude of the Moon.—The moon's distance from the earth is found from her horizontal parallax, which may be determined either by simultaneous observations at stations very distant from each other, or by means of the occultations of fixed stars by the moon. From such observations it is found that the amount of the parallax varies considerably at different times. Its mean value gives the average distance of the moon from the earth, equal to 59·9 of the earth's equatorial semidiameters, or about 237,000 miles, which is upwards of 400 times less than the distance of the sun. Combining this result with the apparent magnitude (31′ 26″) of the moon's diameter, when at her mean distance, it results that the diameter of the moon is to that of the earth in the proportion nearly of 3 to 11; whence the volume of the moon is only about 1-49th of the volume of the earth.

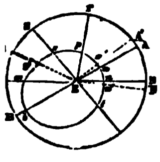
A recent discovery has shown us that the telescopic diameter of the moon is about 2″ larger than the real one. This may be due to irradiation entirely, or to irradiation and an atmosphere.

Inclination and Nodes of the Lunar Orbit.—The moon's orbit is inclined to the ecliptic under an angle of 5° 8′ 47·9″; but the line in which it intersects the ecliptic, or the *line of the nodes*, does not maintain a fixed position on the plane of the ecliptic. It is observed that the moon passes from one of the nodes to the opposite one in less time than is required to pass through 180° of longitude; hence the line of the nodes has a retrograde motion on the ecliptic; and its motion is so considerable that it completes a revolution, or returns to its former position, in a period of 6798·28 days, or about 18·6 years. This period is remarkable, as being that after which the eclipses of the sun and moon again return nearly in the same order. The cause of the regression of the line of the nodes is the attractive power of the sun, which is always tending to draw the moon into the plane of the ecliptic, and which would at length cause her orbit to coincide with that plane, were the tendency not counteracted by the angular motion of the moon round the earth. By reason of the angular motion the mean inclination remains the same, and the resulting effect is the retrograde motion of the nodes. But as the sun's distance from the earth is a variable quantity, the effect of the solar action in displacing the moon's orbit is also variable. Hence, and also on various other accounts, the motion of the nodes, and the inclination of the lunar orbit to the ecliptic, are subject to certain periodical changes, all which must be accurately appreciated and computed in the formation of the lunar tables. [PERTURBATIONS.]

Eccentricity of the Lunar Orbit.—The general orbit of the moon is an ellipse, having the earth at one of its foci; but on account of the disturbing force of the sun, and the difference of the intensities of this force when the moon is differently situated relatively to the earth and sun, the ellipse is constantly changing its form and position on the plane of the orbit; and hence the numerical values assigned to all its elements are to be considered only as average or mean values. The distance of the moon from the earth when in *apogee*, or at her greatest distance, is 63·842 semidiameters of the earth; and when in *perigee*, or at her least distance, 55·916 semidiameters; whence the eccentricity, or distance of the focus from the centre, is about 0·066, half the major axis being taken as unity. According to the best tables, it is 0·0548442. On comparing the positions of the major axis, which is called the line of the *apsides*, at different times, in respect of the fixed stars, it is found to have a rapid motion eastward, completing a whole circuit in 3232·57 mean solar days, or nearly nine years. But this mean motion is subject to inequalities of considerable magnitude. The different situations of the line of the apsides with respect to the line of the syzygies gives

rise to the inequality of the lunar motion, called the *evection*. [EVECTION.]

Different Species of Lunar Months.—As the principal points of the lunar orbit—the syzygies, the nodes, the apsides—are in a state of rotation with different velocities, and in different directions, it follows that the period of time in which the moon completes a revolution with respect to any of these points, or to the fixed stars, will be different in each case. These periods, which are called lunar *months*, may be explained as follows: Let E be the centre of the earth, *a s b t* the orbit of the moon, *a b* the transverse axis or line of the apsides, *s t* the line of the syzygies, *n m* the line of the nodes, and A S B N the great circle of the sphere in the plane of the ecliptic. Also, let P be a fixed point on this circle; and suppose the moon to be at *p*, or seen in the direction E P. The time which elapses while the moon passes from *p*, and returns to the same point of the ecliptic, is called the *tropical* revolution, and differs only about seven seconds from the time in which the moon returns to the same fixed star, or performs a *sidereal* revolution. Suppose now the moon to be at *s*, in the line of the syzygies; when the moon advancing from *s*, in the direction *m b n*, has again come round to the same point of the ecliptic, she will not now be in conjunction; for, in the interval, the sun has advanced from S to S′ (nearly a twelfth of the circumference), and consequently the moon must go on to *s*′, till she overtakes the sun, before she returns to her conjunction. The interval from conjunction to conjunction is the *synodic period*, and exceeds the tropical period by two days and about five hours. Next, suppose the moon to be at her perigee *a*, or seen in the direction E A; while the moon, after leaving *a*, is describing her orbit, the line of the apsides E A revolves through the angle A E A′, and consequently the moon, after coming into the line E A, must continue to advance till she comes to *a*′ before she arrives again at her perigee. The interval from perigee to perigee is called the *anomalistic period*; and it is also longer than the tropical period, though much shorter than the synodic, inasmuch as the line of the apsides requires about nine years to complete its revolution, while that of the syzygies is completed in one year. Lastly, suppose the moon at *n* in the line of the nodes. While the moon is advancing round her orbit, the line of the nodes, E N, moves backward into the direction E N′; consequently the moon will have come up to her node at *n*′ before she has completed a revolution on the ecliptic. The interval from node to node is called the *nodical period*, and is shorter than any of the other periods. The following table exhibits, in mean solar days, the mean lengths of the different lunar periods or months:—



	Days
Synodic revolution	29·53059
Sidereal . . .	27·32166
Tropical . . .	27·32158
Anomalistic . . .	27·55460
Nodical . . .	27·21222

Acceleration of the Moon's mean Motion.—On comparing observations of the moon made at distant intervals of time, it has been discovered that her mean motion has been undergoing a constant acceleration since the earliest times. This acceleration is, however, extremely small, amounting only to 10″ in a century, and therefore is insensible for any moderate interval of time, though it becomes discernible after a few centuries. Being measured by centuries, it is called the *secular acceleration* of the mean motion. Its physical cause was found by Laplace to be a diminution of the eccentricity of the earth's orbit For descriptions of *eclipses of the moon, eclipses of the sun by the moon, rotation and libration of the moon*, see ECLIPSE and LIBRATION.

Appearance and Physical Constitution of the Moon.—On looking at the moon with the naked eye, her disc appears diversified by dark and bright patches, which are due to the unequal reflection of light by different portions of the lunar surface, and not to mountains and valleys as is commonly supposed. A very moderate telescopic power, however, suffices to show that nearly the whole surface of the moon is covered with elevations and depressions, which are especially evident at the line of separation (called the *terminator*) between the illuminated and dark hemispheres. This line, which, if the surface were even, would be sharply defined, is at all times extremely ragged, and indented with deep recesses and prominent points. The mountains near it cast behind them long black shadows (as do mountains on the earth when the sun is in the horizon), from the micrometrical measurement of which the height of the mountains may be calculated. According to Sir J. Herschel, some of the highest of them exceed 1¾ English mile in perpendicular altitude. Tycho, the bright spot in the south-east quarter from which the rays seem to run, is apparently a volcanic crater, 50 miles in diameter and 16,000 feet deep, surrounded by broad terraces within, and with a central mountain about 5,000 feet high. Schroeter has estimated the average height of the lunar mountains to be upwards of five English miles; but it is easy to see that the measurement is not susceptible of much accuracy.

'The generality of the lunar mountains,' says Sir J. Herschel, 'present a striking uniformity and singularity of aspect. They are wonderfully numerous, occupying by far the larger portion of the surface, and almost universally of an exactly circular or cup-shaped form, foreshortened, however, into ellipses towards the limb; but the larger have for the most part flat bottoms within, from which rises centrally a small, steep, conical hill. They

offer, in short, in its highest perfection, the true volcanic character, as it may be seen in the crater of Vesuvius; and, in some of the principal ones, decisive marks of volcanic stratification, arising from successive deposits of ejected matter, may be clearly traced with powerful telescopes. What is, moreover, extremely singular in the geology of the moon is, that although nothing having the character of seas can be traced (for the dusky spots which are commonly called *seas*, when closely examined, present appearances incompatible with the supposition of deep water), yet there are large regions perfectly level, and apparently of a decided alluvial character.' ('Astronomy,' *Cabinet Cyclopædia*, p. 229.)

The moon has no atmosphere, or at least none of sufficient density to refract the rays of light in their passage through it. There is consequently no water on her surface; and no animal similarly constituted to those which inhabit the earth could subsist there. Her surface presents no appearance of vegetation, or of variation which can be ascribed to a change of seasons. Everything appears solid, desolate, and unfit for the support of animal or vegetable life. Whether the materials of which the lunar substance is composed are of the same nature as those which compose the earth, there are no means of knowing. From the effect of the moon's gravitation in producing the nutation of the earth's axis, the mass of the moon is determined to be very nearly 1–80th of the mass of the earth; whence, as her volume is only 1-49th of the earth's volume, it results that her density, as compared with the mean density of the earth, is ·615, or a little more than one-half.

Moonstone. A transparent or translucent variety of Adularia, which, by reflected light, presents a pearly or silvery play of colour, not unlike that of the moon. It is held in considerable estimation as an ornamental stone, especially on the Continent, and is sometimes cut into ring and brooch stones. The finest specimens are brought from Ceylon.

Moor. An uncultivated surface without trees, with few grasses or other herbage fit for pasture, and generally containing scattered plants of heath, with a dark peaty soil. Moor lands are generally the least fitted for culture of any kind of surface, not rocky or mountainous. Moors are covered with a very thin layer of soft, black, sterile soil; and the subsoil is generally gravel, or retentive ferruginous clay. By the destruction of the heath, or other bad herbage, by deep tillage and the use of lime, and manuring with bone-dust, guano, &c., as may be practicable, and by sowing down with grass seeds, they may be improved. In many cases, also, trees will grow on drained moors; in which case the soil ultimately becomes ameliorated by the fall and decay of the leaves.

Moor (Dutch marren, *to tie*; Fr. amarrer). In Navigation, this word signifies generally to fix a vessel by two anchors in nearly opposite directions, so that she *rides* by either in certain winds, or partly by both in other winds; also to secure a vessel to weights or chains sunk in harbours for the purpose. These weights are called *mooring blocks* and the whole apparatus *moorings*.

Moorballs. The curious sponge-like balls found at the bottom of fresh-water lakes, and consisting of plants of *Conferva ægagropila* in their natural state. The whole plant, observes Mr. Berkeley, consists of a mass of branched articulated green threads, somewhat resembling the hair-balls found in the stomachs of ruminants.

Moorish Architecture. [ARCHITECTURE.]

Moplahs. The Mohammedan inhabitants of Malabar, descended from Moors and Arabians who have settled on that coast and married Malabar women. They are said to form a fourth of the population. They are commercial and industrious on the coast, but have occasionally shown themselves a furious race in the interior. (Forbes, *Oriental Memoirs*, p. 258.)

Mora (its native Guiana name). A genus of *Leguminosæ* comprising the Mora of Guiana, a gigantic timber tree, 100 to 150 feet high, of which extensive forests exist both in Guiana and Trinidad. The wood is very tough and close-grained, and under the name of Mora timber is largely imported for shipbuilding. One of its most valuable properties is its non-liability to splinter. The species is called *M. excelsa*.

Moraceæ (Morus, one of the genera). A natural order of diclinous Exogens of the Urtical alliance, distinguished by the technical peculiarities of having solitary suspended ovules, and a hooked albuminous embryo with a superior radicle. They are trees or shrubs with variously formed leaves, commonly rough, accompanied by large stipules, and small unisexual flowers collected into heads, spikes, or catkins. They occur both in temperate and tropical climates, and abound in milky juice, often yielding caoutchouc. The order embraces the Fig family (*Ficus* with its offshoots), and the Mulberries (*Morus*), with a few other genera.

Moraine. A Swiss term, introduced into the technical language of Geology, meaning the débris or broken fragments of rocks brought down into the valleys below by glaciers. Such moraines are common in the Alps and in other lofty mountain chains. They are found also occasionally where there are now no great glaciers. They assist greatly in determining the history of some of the more remarkable deposits of gravel in Europe. [GLACIER.]

Morals. [ETHICS.]

Morana. The old Bohemian goddess of winter and of death: the Maryana of Scandinavia. A grand yearly festival was celebrated in honour of this goddess in the month of March. Her image was conveyed solemnly to the nearest brook or rivulet, and thrown into it amid the rejoicings of the people. This festival was called *Das Joden-Austreiben, das*

Sommer gewinnen; and, as the words imply, was intended to be symbolical of the end of winter and the return of spring. (Grimm's *Deutsche Mythologie*, p. 446.)

Morass. Moor lands saturated with water to such an extent as not to bear the tread of cattle. A morass is to a moor what a marsh is to a meadow. It is evident that the drainage of morasses and moors, by lessening the evaporation of water from their surfaces, must tend to improve the local climate.

Moravian Brethren. [HERRNHUT.]

Morbidezza (Ital.). In Painting, a softness and delicacy of style. Its opposite is a style in which the lines are harsh and angular.

Mordant (Fr.; Lat. mordeo, *I bite*). A substance used to fix colouring matters upon different stuffs. [DYEING.] Alumina and oxide of iron are among the most important mordants.

Mordella (Lat. mordeo, *I bite*). A Linnæan genus of Coleopterous insects, the type of a family (*Mordellidæ*) of Latreille's *Heteromerans*, distinguished by the general form of the body, which is elevated and arched; with the head low; the thorax trapezoidal or semicircular; the elytra very short, or narrow and pointed at the tips, as well as the abdomen. They are distinguished from their nearest congeners, as the *Pyrochroidæ*, by their extreme agility, the firm texture of their integuments, and their tenacious and painful bite. The subgenera of the *Mordellidæ* are *Ripiphorus*, *Myodites*, *Pelecotoma*, *Anaspis*, and *Mordella* proper: to the last subgenus are now restricted the species of the present family, which have the antennæ of equal thickness throughout, and slightly serrated in the males; the eyes not emarginate, and the abdomen terminated by a long point.

Mordenite. A zeolitic mineral found in the form of concretions in a trap rock near East Morden, in the bay of Fundy.

Mordente (Ital.). In Music, a grace in use by the Italian school, which is effected by turning upon a note without using the note below.

Morel (Ger. morchel). The *Morchella esculenta*, one of the few fungi found in this country which may be used as food with safety. It occasionally occurs in woods and orchards, whence it finds its way to the markets; but it is of comparatively rare occurrence. It has a hollow stalk an inch or two high, and a yellowish or greyish ribbed head two or three inches deep.

Moresque (Fr.). In Painting or Sculpture, a species of Arabesque or Saracenic ornament, in which foliage, fruits, flowers, &c. conventionally treated, are combined, by springing out of each other, without the introduction of the human figure, or that of any animals. It has received its name from having been much used by the Moors, who, however, were not the inventors of it. It was developed by Byzantine Greeks, who were employed by the early Arab conquerors in the decoration of their mosques, in which no imitation of nature could be tolerated. Much of this ornament is still preserved in Egypt, in Sicily, and in Spain.

Morganatic Marriage or **Left-handed Marriage** (said to be derived from the Gothic word morgjan, *to shorten*). A marriage between a man of superior and a woman of inferior rank, in which it is stipulated that the latter and her children shall not enjoy the rank or inherit the possessions of her husband. Such marriages are not uncommon in the families of sovereign princes, and of the higher nobility, in Germany; but they are restricted to personages of these exalted classes.

Morgue (Fr.). The name given to a place in many French towns where the bodies of persons found dead are exposed in order to be recognised and owned by their friends. The clothes in which they were found are placed near the bodies, for their better identification. The Parisian morgue is built on the left bank of the Seine, in one of the most populous neighbourhoods of the city.

Moric Acid. *Morin.* A variety of tannic acid existing in the wood of *Morus tinctoria*, or *fustic*.

Morinda (Gr. *μόρον, the mulberry*). This genus of *Cinchonaceæ* yields the plant from which the Ach-root is obtained. The plant is named *M. tinctoria*, and this, together with *M. citrifolia*, *bracteata*, and *umbellata*, is used for dyeing purposes in India and Ceylon.

Morindin. A crystallisable substance obtained from the root of *Morinda citrifolia*.

Moringaceæ (Moringa, one of the genera). A natural order of hypogynous Exogens, belonging to the Violal alliance. It includes but few species, small trees with bi-tripinnated leaves, and white panicled flowers. These are found in India and Arabia. *Moringa pterygosperma* is a stimulant and rubefacient, and its seeds form the Ben-nuts of old writers. The order is known by its many-leaved calyx, its perigynous petals and stamens, its one-celled anthers, its stipulate siliquose fruit, and its exalbuminous seeds.

Moringic Acid. An oily acid obtained from oil of ben, which is expressed from the fruit of *Moringa pterygosperma*.

Morion. A lapidaries' name for black Rock Crystal. Also, a helmet worn by men-at-arms.

Moritannic Acid. A modification of tannic acid, forming part of the colouring matter of fustic (*Morus tinctoria*).

Mormon (Gr. *μορμών*, or *μορμώ, a mask*). The generic name for the short-winged web-footed birds, usually called Puffins, the singular beak of which gives the head the appearance of a grotesque mask. The depth of the base of the bill equals that of the entire head, and frequently the length of the bill itself: the mandibles are compressed, arched, obliquely channelled, and notched towards the tip. The eggs and young birds are sought after and taken in great numbers in the Orkneys and Faroe Isles.

The name commonly given to a religious system of which the head quarters are now in the United States of America, although many congregations of its sectaries exist both in Britain and on the continent of Europe. The 'Mormons' are also termed Latter-day Saints. The founder of the sect was one Joseph Smith, an American of Vermont, settled in the state of New York. His religious romance, *The Book of Mormon, an Account written by the Hand of Mormon, upon Plates taken from the Plates of Mormon*, was first printed at Palmyra, New York, in 1830. It was followed by his *Book of Doctrines and Covenants of the Church of Jesus of Latter-day Saints*, in 1832. *The Latter-day Saint's Millennial Star*, a periodical still continuing, and the *Journal of Discourses*, by Brigham Young (the present chief of the sect), and others appearing in semi-monthly numbers, are regarded as the authoritative exposition of the creed of this body. The Mormons, under the leadership of Joseph Smith, multiplied and prospered in the United States, though not without persecutions, until 1844, when their establishment at Nauvoo, in Illinois, was sacked and destroyed by a popular movement, and Joseph Smith himself murdered by a mob. In 1846 the Mormon exodus from Illinois began, under Brigham Young, who in 1845 had assumed the 'presidency of the twelve apostles,' and became the leader of the church. In 1848 they established themselves in 'Great Salt Lake City,' in Utah territory, a region among the Rocky Mountains, in the central portion of the North American continent. Here they have since maintained themselves, not without frequent collisions with the authorities of the United States, sent in virtue of the constitution to maintain the Federal Government among them. The 'saints' in Utah are commonly estimated at from 40,000 to 50,000 souls: there are said to be 40,000 members in the 'European mission,' and the annual emigration to Utah, carried on mainly by a common fund (before the late war in the States), was 3,000 or 4,000; but these numbers must be received with much distrust; the Mormon authorities themselves rate them far higher. Mormonism derives its recruits chiefly from England, Wales, and the northern parts of Europe.

The original impulse towards Mormonism lay in that craving after the continuance of a visible governing, miracle-working authority in the church, which Roman Catholicism recognises and satisfies, but which in Protestant communities finds vent in the constant succession and temporary popularity of sects such as the Irvingites, Plymouth Brethren, and so forth. But it may well be thought that nothing except an extremely low state of education, and almost total absence of religious training, could have brought tendencies and cravings such as these into connection with the coarse and even ludicrous pretensions of such a personage as Joseph Smith. His *Book of Mormon* is described by the Rev. H. Caswall, author of one of the earliest accounts of the sect, to be nothing but a plagiarism from an unpublished romance, in biblical style, written by one Solomon Spaulding, a minister of religion. However this may be, the imaginary 'plates' on which the revelation was inscribed have never been revealed to any eyes but those of the prophet himself. It professes to record the history of the family of Lehi, and his son Nephi, who left Jerusalem B.C. 600, and introduced the worship of the true God into America; the 'Nephites' received Christianity through the direct interposition of our Saviour Himself; and were finally destroyed by infidels, A.D. 421, when Moroni, the last survivor, finished and sealed up the 'records,' which in the fulness of time came into the hands of Joseph Smith. But the system of belief now preached by them is not to be learnt from these fanciful records, but from subsequent commentaries. They profess belief in the Trinity and Atonement: in the ordinances of faith, baptism by immersion, laying on of hands, and the holy supper: in an apostolic succession of the ministry: in the continuance of 'gifts' to the church; namely, prophecy, revelations, visions, healings, tongues, &c.: in the second coming of the Messiah: in the literal gathering of Israel, the restoration of the ten tribes, and in the personal reign of Christ for a thousand years. [MILLENNIUM.] The principle and practice of polygamy, now commonly regarded as the most characteristic part of their institutions, did not exist among them from the beginning, but were authorised by 'A Revelation on the Patriarchal Order of Matrimony, and Plurality of Wives,' made to Joseph Smith in 1843. The hierarchy of the Mormons consists of several orders: 1. The 'first presidency' of three members, over whom, however, the first, now Brigham Young, has supremacy: 2. The 'patriarch,' a kind of office of dignity rather than government: 3. The second presidency of twelve: 4. The seventy: 5. The high priests, including the 'bishops' or superintendents, and the 'high council' of twelve, a sort of spiritual court of justice between believers. For accounts of the early Mormon history may be particularly consulted the publications of Lieut. Gunnison and Col. Kane, United States officers: for hostile, but more or less trustworthy, sketches of their faith and practice, those of J. C. Bennett, an apostate from their persuasion; the Rev. H. Caswall, chap. xiii. of *America and the American Church*, 1851; Conybeare 'On Mormonism' (*Edinburgh Review* for 1854); the narratives of Mrs. Mary Ettie and other female writers, on the usages of Mormonite polygamy; Montégut, 'Le Mormonisme' (*Revue des Deux Mondes*). But this article has been chiefly compiled from the information contained in one of the last works on the subject, the *City of the Saints*, by the well-known traveller Richard F. Burton, a work written in an unusual spirit of favour towards this great imposture and its professors.

Mormyrus (Gr. μορμύρος, a name given by the Greeks to a shore-frequenting fish of a variegated colour, probably the *Sparus Mormyrus* of Linnæus). The name was applied by Linnæus to a genus of abdominal fishes placed in the Malacopterygian order, between the *Lucioid* and *Siluroid* families in the system of Cuvier. The *Mormyri* differ from the pikes in little else save in the small size of their mouth, of which the angles are formed by the maxillary bones; and in a corresponding modification of the alimentary canal, the intestines being longer, and complicated by two cæca. The *Mormyri* are confined to the rivers of Africa, and are reckoned the best-flavoured fishes that are caught in the Nile.

Morocco (Fr. maroquin). A species of goatskin leather, originally imported from the Levant and Barbary states. It is extensively used in the binding of books. [LEATHER.]

Moronobea. The Hog-gum tree, *M. coccinea*, is a loft· South American and West Indian tree, ›nging to the *Clusiaceæ*, and forms a straight trunk one hundred feet high, with smooth horizontal branches, and thick entire glossy leaves. A juice exudes from incisions of the trunk. This juice hardens into a yellowish resin, and has been employed medicinally as a substitute for copaiba. In Brazil and Guiana the natives use it for torches, and to pitch their boats.

Moroxite (Gr. μόροξος, the name of an Egyptian stone). An opaque greenish-blue variety of Apatite from Arendal in Norway, and Pargas in Finland.

Moroxylic Acid. An acid discovered by Klaproth in the bark of the *Morus alba*, or white mulberry-tree.

Morpheus (Gr.). In Ancient Mythology, the god of dreams; the son of Ὕπνος or Somnus, so called as shaping or fashioning the dreams of the sleeper.

Morphia (Lat. Morpheus). The narcotic principle of opium. It may be separated from opium in the form of white prismatic crystals almost insoluble in water, but soluble in boiling alcohol; it combines with the acids and forms salts, all of which are sedatives, and of great therapeutic value as medicines. Of these the hydrochlorate of morphia is perhaps the best. The acetate of morphia is also a valuable preparation. One of the most characteristic chemical properties of morphia and its salts is that they decompose iodic acid, and consequently immediately discolour its aqueous solution. The ultimate elements of morphia are carbon, hydrogen, oxygen, and nitrogen, and may be represented by the formula $C_{35}H_{20}O_4N$. [OPIUM.]

Morphnus (Gr. μόρφνος, *dusky*, a name applied by Aristotle to the osprey). This term is restricted by Cuvier to a genus of *Accipitres* called eagle-hawks, having wings shorter than the tail, but with long and slender tarsi and comparatively feeble toes. Some species have the tarsi naked and scutellated, as the *Morphnus guianensis*.

Morphology (Gr. μορφή, *form*, and λόγος). In Botany, that department or division of the science which treats of the metamorphosis of organs. It appears, from the comparison of one kind of organ with another, that notwithstanding the differences between them, there are so many close analogies, and so much identity of structure, as to render it probable that they are all formed upon one common plan, modified according to the purposes for which they are severally destined. The leaf, which is the most universal of the external organs, is taken as the best representation of this type; and with the more reason, because all the other parts are found to have a tendency to assume the organisation of a leaf, when any disturbing cause interferes with their developement. According to morphological writers, the scale of a leaf bud is a rudimentary leaf; the petal is a leaf reduced in size, and thinned or coloured, or both; the stamen is a leaf, whose petiole is represented by the filament, while the two lobes of the anther are the two sides of its lamina; and the pollen is the disintegrated mesophyll, and so on. These conclusions were for a long time ridiculed by many writers; but they gradually gained ground with philosophical botanists, and are now the foundation of comparative anatomy in plants. At the present day the question is indeed no longer speculative, but is decided by the evidence of our eyes; for all those transformations the necessity of which morphologists assumed by mere force of reasoning have now been witnessed by Schleiden and many others, who have traced the developement of the organs of plants from their earliest condition, through all their modifications, up to the period of complete developement, and have found that they are all deviations from a common type subsequent to the first stage of their growth.

In Zoology, morphology is the history of the modifications of form which the organ undergoes in the same or in different organisms. The science has been advanced during the last twenty years by the labours of the so-called *transcendental anatomists*, and has been most successful when applied to the modifications of the vertebrate skeleton. The principles on which the science is founded are detailed in the articles ARCHETYPE; HOMOLOGUE; SKELETON; and VERTEBRA [which see].

Morrice Dance or **Morris Dance** (a corruption of Moresco or Moorish dances). A peculiar kind of dance practised in the middle ages. It is supposed to have been first introduced into England from Spain by Edward III., when John of Gaunt returned from that country; but few traces of it are found earlier than the times of Henry VIII.; and it is more probable that it was borrowed either from the French or the Flemings. In the morris dance bells were fixed to the feet of the performer, and the great art consisted in so moving the feet as to produce something like concord from the various bells.

(Lat. from the root mar, *to pound or grind* [LANGUAGE]). In Latin Mythology, the goddess of death.

Mortality, Bills of. Bills of mortality are extracts from parish registers, showing the numbers who have died in some fixed period of time, as a year, a month, or a week; and hence they are called *yearly, monthly*, or *weekly bills*. In general, they also contain the numbers of baptisms, and sometimes the numbers of marriages. To be correct, these bills should state the condition of all that die at every age, whether boys, married men, widowers, or bachelors; the corresponding distinctions being likewise given for females. Such lists of persons of both sexes dying of every disease in every month and at every age would, when compared with records of seasons and local circumstances, tend greatly to the increase of medical knowledge, and afford the necessary data for determining the duration of life between males and females.

The keeping of parish registers was begun in England in the year 1538, in consequence of an injunction issued by Lord Cromwell, the king's vicegerent in ecclesiastical affairs, after the abolition of the papal authority in the kingdom. In Germany they appear to have been introduced at a somewhat earlier period, for Süssmilch has given extracts from the Augsburg bills which go back to the year 1501; and they were established in most countries of Europe about the beginning of the seventeenth century.

The London bills, containing the records of baptisms and deaths, were begun in the year 1592, but were not kept regularly till after the plague which prevailed in 1603; since which time they have been continued weekly, and an annual bill has been also regularly published. Their value, however, was very little understood; nor do they seem to have attracted much notice until 1662, when Graunt published his *Natural and Political Observation on the Bills of Mortality*, a work of great merit, considering the time at which it was written. The ages at which the deaths took place were not inserted in the bills till 1728. Throughout the country the registers were kept, generally speaking, with very little care; but the Act for the registration of births, marriages, and deaths, which came into operation in 1836, has introduced an incomparably better system; and, as the sex, ages, and causes of death are now recorded, the public is in possession of far more authentic information than before existed on some of the most interesting questions of social statistics. (See article 'Mortality,' in the *Encyclopædia Britannica*, 8th edition; Preface to the *Population Returns for* 1831; *Annual Reports of the Registrar-General of Births, Deaths, and Marriages in England*, 1839 *et seq.*; Price *On Reversionary Payments*.)

Mortality, Law of. By this term is usually understood a mathematical relation subsisting among the numbers of persons living at the different ages of life; such that, the number of persons living at any assigned age being given, the number of them who remain alive at every subsequent age, and consequently the mortality which takes place in the interval, will be expressible by that relation. It must be obvious that in speaking of a law of this kind, we can only have regard to the averages of large numbers. In respect of a single individual, or a small number of persons, the uncertainty of the duration of life is proverbial; but the case is entirely changed when multitudes are concerned; and there are few classes of contingent events of which the results can be predicted with so little risk of departure from the truth as the average age to which the lives of a considerable number of persons will be prolonged.

The circumstances which affect the mean duration of human life depend upon a great number of different causes; as climate, the facility of obtaining subsistence, the state of civilisation, the manner of living, progress of medical science, &c., all of which vary in different countries and at different times. The law of mortality, therefore, must vary with these circumstances; and consequently, if expressible by any mathematical function, it must be one affected by numerical coefficients depending on the particular circumstances, and of which the values can only be determined by observation. The simplest expression which has been proposed for representing the course of mortality is that which is derived from the celebrated hypothesis of De Moivre; namely, that if a number of individuals be taken in any given year of age, the number of deaths which take place among them will be the same every year until the whole are extinct. In this hypothesis only one numerical quantity requires to be determined, viz. the average extreme age. De Moivre adopted 86; and his hypothesis may therefore be simply enunciated as follows: Out of 86 infants born, 85 will be alive at the end of the first year, 84 at the end of the second, and so on to the extremity of life, the decrement being one in each year. For a considerable number of years, about the middle ages of life, this hypothesis of equal decrements represents the observed facts with tolerable accuracy; and, as it affords considerable facilities in various calculations, it was formerly much used in the computation of life contingencies. The difference between the given age and 86 is called by De Moivre the *complement of life*; thus the complement of a life of 50 is 36 years.

If we suppose a straight line to be divided into a number of equal parts, representing the ages of human life, and perpendiculars to be drawn through the points of division proportional to the number of survivors at each age out of a given number taken at a previous age; a curve line drawn through the extremities of all those perpendiculars will represent the law of mortality as indicated by the observations, and the equation of the curve will be the relation between the age and the mortality.

Now it is possible to draw an algebraic curve through any number of points; but, in the present case, this method of proceeding is attended with no advantage; for if the number of points be great, as it necessarily must, the equation is of a high order, and its numerical computation impracticable. Lambert, of Berlin, who appears to have been the first who exhibited the law of mortality by a curve line, constructed a somewhat complicated empirical formula, which represented the mortality observed in London during some part of the last century with considerable accuracy, and which may be adapted to any other set of observations by giving suitable values to its numerical coefficients. But the most ingenious attempt which has been made to deduce a formula from à priori considerations is contained in a paper by the late Mr. Benjamin Gompertz, published in the *Philosophical Transactions* for 1825. Mr. Gompertz assumed as a principle that there is a power in human life to resist the effects of disease, or oppose destruction, which loses equal proportions of its intensity in successive equal small intervals of time; and from this he derived an expression which gives the number of survivors (y) of any number of individuals, taken at any given age, at the end of any number of years (x) counted from that age, in terms of three constants, which may be determined from observations. The formula may be given under this form:—

$$\log y = \log l \pm \text{No. whose log is} \\ (\log \log p + x \log q),$$

l, p, and q being the constants to be determined. On assuming three ages, and taking the corresponding values of x and y from the Carlisle table, and determining the constants by means of the three equations so formed, the formula is found to agree with the table through all the ages, within limits which may be fairly supposed not to exceed the errors of the observations. A supplement to Mr. Gompertz' paper of 1825 will be found in the *Phil. Trans.* for 1862.

On account of the multitude of causes which influence the rate of mortality among the inhabitants of a country, it is plain that any formula deduced from à priori considerations can only be trusted so far as it is found to agree with experience; and therefore, for all practical purposes, recourse is had to a table showing for each year of age the number of deaths which are observed to take place out of a large number of persons who enter upon that age. The ratio of those two numbers is the measure of the probability that an individual entering upon that age will not survive the year, and may be assumed as the law of mortality in respect of that age. The table may be exhibited under different forms: the most usual is a table of decrements, which is constructed by supposing a large number of persons, as 10,000, for example, to start together in the same year of age (the year of birth is usually assumed), and to write down in the same column the number of those who remain alive at the end of each successive year. From this the number who die in each year, and the chances of surviving a year, or any number of years, are easily found. For some purposes the table of the probabilities of living over a year at each age, or of dying in the course of the year, is more convenient; but either form can be readily reduced to the other.

The first outline of a life table was traced by Graunt in his *Observations on the Bills of Mortality* 1662–1678; but the oldest complete table which we possess is published in the *Philosophical Transactions* for 1693, and was constructed by Halley from the mortuary registers of Breslau, in Silesia. This town was selected, because the number of births having been nearly equal to the number of deaths for some years, it might be assumed that the population had remained in a nearly stationary state during that time—an assumption which affords the means of determining the ratio of the number who die at each age to the number who entered upon that age; for it is evident that in a place so circumstanced, and supposing also there is no migration, the number who survive or complete any year of age within a given period is equal to the sum of the deaths at all the greater ages during the same period. For the sake of facilitating calculations from the table, he reduced the numbers proportionally to 1,000, by which number he represented the infants of one year of age.

This method of determining the mortality from the mortuary registers, or *bills of mortality*, has been frequently adopted, particularly by Dr. Smart, in the formation of a table showing the mortality in the city of London about the middle of the last century; by St. Maur, in respect of Paris; and by Dr. Price for the celebrated Northampton table, presently to be described. But it is evident that as the population of a large town or district of country can never be absolutely stationary, and as migration must be constantly taking place to a greater or less extent, the method is not absolutely correct; and, in fact, the results to which it leads must be attended with great uncertainty. In order to obtain accurate results, it is necessary to know the numbers who actually enter upon each year of age, as well as the numbers who die in that age, during the period included in the observation; and hence, in addition to the mortuary register, an enumeration in each year, or at short intervals, of the community in the several ages of life, is requisite for the accurate solution of the problem. But, although great attention has been given of late years to the statistics of life, in various countries of Europe, it is only in a very few instances that sufficiently accurate data for the construction of a mortality table have been obtained from observations embracing indiscriminately all the different classes of the inhabitants. Of these few, the principal (if not the only) instances are the observations made in Sweden and Norway

those of Dr. Heysham, at Carlisle; and more recently by Dr. Cleland, at Glasgow. With these may be noticed Hodgson's *Observations on the Duration of Life amongst the Clergy of England and Wales, extending over a Period of 100 Years, each Life being separately traced* (1864).

In consequence of the migration which is constantly going on among the inhabitants, it is very difficult to obtain with certainty the data necessary for determining the mortality of any town or district; but there are various associations of individuals with respect to which precise data exist. Such, for example, are the religious houses in Catholic countries; he tontines which were established in different countries of Europe during the last century; the annuitants of the British government; and especially the life assurance companies, now become so numerous. In all such associations, the numbers who enter upon and die in each year of age can be ascertained with precision from the records of the association, which, therefore, afford the data requisite for determining the rate of mortality at the different ages, without hypothesis of any kind. Tables were thus constructed by Kersseboom, from Dutch registers of annuitants; by De Parcieux, from the lists of the nominees in the French tontines, chiefly of 1689 and 1696, and from the mortuary registers of the Benedictines, and of the nuns in several convents in Paris; and by Mr. Finlaison, from six different classes of annuitants in English and Irish tontines. Of the assurance offices, the Equitable Society and the Amicable Society have published their experience separately; and in 1843 a series of tables was published under the superintendence of a committee of actuaries, exhibiting the law of mortality deduced from the combined experience of seventeen offices, including the two above named.

We shall now give a comparative view of the mean duration of life at the different ages, computed from some of the best known tables, premising a short account of each table.

1. *Northampton Table.*—This table, which in this country is perhaps better known than any other, on account of its having been adopted by the greater number of the assurance offices as the basis of their tables of premiums, was constructed by Dr. Price, from the bills of mortality from 1735 to 1780 of the parish of All Saints, in the city of Northampton. It cannot be considered as possessing much authority, either on account of the accuracy of the data, or the number of lives of which it embraces the history; and the hypotheses made use of in its formation—namely, that the number of inhabitants and the number of annual deaths remained the same during the forty-six years included in the observations, and also that the migrations all took place at the age of twenty years, so far tend to reduce its value that at the present time only some twelve or thirteen offices retain it as the basis of their tables. It differs from the modern tables in giving a much lower expectation of life at the younger and middle ages; a circumstance which may be in part owing to the improved condition of the labouring classes of the people, but probably in a much greater degree to the inaccuracy of the observations. (Price *On Reversionary Payments*, 4th ed. 1783.)

2. *Carlisle Table.* — This was constructed by Mr. Milne, from registers kept by Dr. Heysham of the births and deaths which took place in the parishes of St. Mary and St. Cuthbert, Carlisle, in the nine years from 1779 to 1787, the number of inhabitants having been determined by two enumerations which were made during that interval. On account of the accuracy of the data, and the skilful manner in which they were made use of, this table is of considerable authority, though it probably gives a somewhat too favourable view of the duration of life as experienced among the inhabitants of England generally. (Milne's *Treatise on Annuities, &c.* 1815.)

3. *Government Tables.*—These tables, as already mentioned, were computed by Mr. Finlaison, from observations of the mortality among the nominees of life annuities granted by the British government. Mr. Finlaison has given twenty-one tables of the probabilities of life; but the recorded facts are contained in only six of them, the others being formed by combinations of these six. (Finlaison's *Report to the Lords of the Treasury*, published by order of the House of Commons, 1829.)

4. *Equitable Society's Table.*—This table, which was originally framed by Mr. Griffith Davies from decrements of life amongst its members, and more fully drawn out by Mr. Arthur Morgan from more complete data, exhibits the mortality which took place in the society from its establishment in 1760 to the end of the year 1829. By reason of the great number of lives contained in it, and the certainty of the data, this is a document of great importance. It will be seen from the subjoined table, that, for ages under fifty, it gives a rather more favourable expectation of life than the government table for males, and agrees nearly with the Carlisle table; but for ages above fifty it gives a less favourable expectation than either of those tables. The observations commence at the age of ten.

5. *The English Life Table.*—This table is described and published in the *Fifth and Sixth Annual Reports of the Registrar-General* (1843 and 1845). It is constructed from the returns to parliament of the ages of the population of England in 1841 and of the deaths registered at different ages in that year, and is probably a close approximation to the mean duration of life in this country. Dr. Farr, of the Registrar-General's Office, has since published (1864) a *New English Life Table* from the returns of two censuses and 6,470,720 deaths registered in seventeen years.

For the sake of avoiding decimal points, the numbers in the subjoined table show the mean

duration of life for ten individuals, or the number of years enjoyed by ten individuals collectively. In respect of a single individual, the mean duration of life is the tenth part of the number given in the table.

Age	Northampton	Carlisle	Government (Males)	Government (Females)	Equitable Society	English Life Table
0	252	387	502	555		411
5	408	513	489	542		500
10	398	488	456	511	483	474
15	365	450	418	472	450	437
20	334	415	384	440	417	403
25	309	379	359	408	381	370
30	283	343	332	376	345	337
35	257	310	302	343	309	304
40	231	276	270	311	274	271
45	205	245	238	278	239	239
50	180	211	203	244	204	206
55	156	176	172	208	170	172
60	132	143	144	173	139	140
65	109	118	116	140	111	112
70	86	92	92	110	87	88
75	65	70	71	85	66	67
80	48	55	49	65	48	51
85	34	41	31	48	34	38
90	24	33	20	28	26	28
95	8	35	12	16	11	20

There are many questions of great interest respecting the law of mortality which cannot yet be satisfactorily answered, from the want of sufficient data. The Carlisle table gives only an indication of local mortality; but it may be asked, whether the mortality is the same in different parts even of the same country, or the same in cities as in rural districts? Now, the government annuitants resided in all different parts of the kingdom; and the same may be said of the members of the Equitable Society, though, perhaps, a majority of the latter were resident in London. But the three tables—namely, the Carlisle table, the table computed from the government male annuitants, and the Equitable Society's table—present a remarkable agreement; and, so far as their evidence goes, we cannot draw any positive conclusion, either in favour of a particular district or a select class of individuals.

It seems to be established beyond doubt that the rate of mortality, at least in England, has undergone a very sensible diminution within a century, especially in respect of children and aged people. This may be ascribed in some degree to the discovery of vaccination; but more especially to the general diffusion of comfort, and the improved mode of living, among the labouring classes of the community.

Another question of great importance is, whether the law of mortality is the same for both sexes? In the above table it will be seen that there is a remarkable disparity between the male and female annuitants in favour of the latter. This indication of the greater longevity of females is confirmed by the observations of De Parcieux on the monks and nuns in the French convents; of Kersseboom, on the Dutch annuitants; of Dr. Price, on the mortality at Chester; and also by the tables constructed from the mortality in Sweden, at Montpellier in France, and in the cities of Amsterdam and Brussels. It is still, however, open to doubt whether the superiority shown in the above instances holds generally true. In the whole population of Belgium, the greater part consisting of peasantry and labourers, it is found that the lives of females are shorter than those of males; while in the towns the advantage is on the side of the females. The combined experience of the seventeen life assurance offices above referred to shows no superiority in the duration of female life.

The following table, showing the proportion of deaths to the population in the principal states of Europe, according to the latest observations, is extracted from a paper in the *Revue Encyclopédique* for July and August, 1833. We cannot vouch for its accuracy, but it is probably not far from the truth.

Countries	Periods or Epochs	Ratio of Mortality to Population
Sweden and Norway .	1821—1825	1 in 47
Denmark	1819	1 in 45
European Russia .	1826	1 in 44-
Kingdom of Poland .	1829	1 in 44
British Islands . .	1818—1821	1 in 55
Netherlands . . .	1827—1828	1 in 38
Germany Proper . .	1825—1828	1 in 45
Prussia	1821- 1826	1 in 39
Austrian Empire . .	1828	1 in 40
France	1825—1827	1 in 39
Switzerland . . .	1827—1828	1 in 40
Portugal	1815—1819	1 in 40
Spain	1801—1826	1 in 40
Italy	1822—1828	1 in 30
Greece	1828	1 in 30
Turkey in Europe . .	1828	1 in 30
Northern Europe . .		1 in 44
Southern Europe . .		1 in 36
The whole of Europe .		1 in 40

For an accurate description of the various mortality tables up to the date of its publication, the reader is referred to the excellent article on the subject, by Mr. Milne, in the *Encyclopædia Britannica*, 8th edition.

Mortar. [CEMENTS.]

MORTAR. In Artillery, a short piece of ordnance, used to throw shells at very high angles (vertical fire), generally 45°, the charge varying with the range required. Mortars are distinguished by the diameters of their bores. They are not mounted on carriages, but on simple *beds* of wood or iron.

Mortar Vessel. A small vessel of considerable beam, for carrying a heavy mortar amidships, which is slung in a massive bed. The mortar vessels were formerly known as *bomb ketches*.

Mortgage (Fr. from mort, *dead*, and gage, *pledge*). In Law, a mortgage deed is in effect an absolute conveyance from the borrower to the lender, with a condition that if a sum of money is paid by a stipulated day the property shall be reconveyed. Thus the grantee has a conditional estate, during the continuance of which the mortgagor, though in possession, is

in contemplation of law only tenant at will to the mortgagee; and on failure of payment, the estate of the mortgagee would become absolute at law. But in equity the mortgagee's estate is subject to an *equity of redemption*, or right to redeem on the part of the mortgagor; and a mortgage is thus redeemable so long as the relation of debtor or creditor appears to subsist between the parties, and for twenty years after the last acknowledgement of that relation by the mortgagee, unless upon his application the right be previously foreclosed by a decree of the court. Mortgages now commonly contain a power authorising the mortgagee to sell the property and repay himself out of the proceeds.

Mortier (Fr.). The name given to a cap of state, of great antiquity, worn by the first kings of France, and the form of which is still preserved in the cap worn by the president *de la cour* of Paris.

Mortification (Lat. mortificus, *causing death*). Local death; gangrene. When any portion of the body loses its vitality, a process of separation takes place between it and the living parts that surround it; and when this happens in certain parts or organs it is necessarily fatal. The symptoms attending mortification of the viscera are generally loss of pain, diminution of fever, small sinking pulse, hiccup, delirium, cold sweat, and fainting, which precedes death.

MORTIFICATION. In Scottish Law, a term nearly synonymous with mortmain in English. By an Act of 1587, land vested in the church was declared to be given for superstitious purposes, and to belong to the crown; and thus the spoliation of the richly endowed church of that country prior to the Reformation was finally legalised.

Mortise (Fr. mortaise, from Lat. mordere, *to bite*). In Architecture, a mortise is the junction of two pieces of wood, or other material, the cavity being cut in one piece to receive the projection left in the other, which is called the tenon or tenant.

Mortmain (Old Fr.). In Law, an alienation of lands, tenements, or hereditaments, to any corporation, sole or aggregate, guild, or fraternity. The foundation of the statute of mortmain is Magna Charta, by which it was rendered unlawful for anyone to give his lands to a religious house, &c. in order to take them back again to hold of the same house; which was extended, by interpretation, so as to annul gifts of lands which religious houses did not give back to the donor to his own use, but kept in their own hands after taking. A great number of statutes were afterwards passed in order to restrict alienations to religious persons and houses, and various devices formed for the purpose of eluding them; of which the system of uses, which has become in some sort the foundation of our law of real property, was one. [REAL PROPERTY; TRUST.] But during the whole of this time the king had the power of dispensing with the statutes of mortmain by granting licenses of alienation; and this power was confirmed to the crown by stat. 7 & 8 Wm. III. c. 37. Gifts for charitable purposes are now subjected, by the Mortmain Act of 9 Geo. II. c. 36, to particular restrictions, a neglect of which frequently invalidates them. The term *mortmain* is derived from the Latin words mortua manus (*dead hand*), because the lands so alienated are said to fall into a dead hand; i.e. one incapable of performing the usual services required of tenants.

Mortuary (Lat. mortuarius, *belonging to the dead*). In Law, a fee paid to the incumbent of a parish, by custom peculiar to some places, on the death of a parishioner. It appears to have been a very ancient usage to present the priest, on the solemnisation of a funeral, with some personal chattel of the deceased, or a sum of money in lieu of it; under the various titles of pecunia sepulchralis, sedatium, in Saxon *soul-shot*, &c. It had become a legal custom as early as the reign of Henry III., when the reservation of a mortuary appears to have been essential to the validity of a testament of chattels. The amount was fixed by 21 Henry VIII. c. 6, according to an ad valorem taxation of the goods of the deceased. Mortuaries (where due by custom) are recoverable in the ecclesiastical courts; and it should appear, since the statute, at common law; although such actions have not hitherto been brought.

Morus (Lat.; Gr. *μόρον*, *the mulberry-tree*). A small genus of plants belonging to the *Moraceæ*, containing some species valuable for their fruit, and others for their foliage. The former is our Mulberry-tree, *Morus nigra*, whose well-known black juicy berries are a favourite autumn production; the latter are *M. alba* and others, which constitute the best of all food for silkworms, but are somewhat tender in our climate, and cannot be usefully cultivated even in the midland country of England.

Morvenite. A variety of Harmotome, found in the granite of Strontian in Argyleshire.

Mosaic or **Musaic** (Lat. musivus). In Painting, representations of objects by means of very minute pieces of stones or pebbles of different colours, or variegated glass carefully inlaid upon a ground generally of metal, are known by this name. This art was practised at a very early period, and was reintroduced to Italy by the Byzantine Greeks. It was applied by the Romans in four different styles: the *opus tessellatum*, the *opus vermiculatum*, the *opus sectile*, and the *opus musivum*. The first three are purely geometric or ornamental, and are strictly only *opus lithostrotum*, i.e. the regular mechanical arrangement of various coloured stones, sometimes in small cubes called tesseræ or tesselIæ, sometimes in slabs of various shapes. The *opus musivum* was the only pictorial mosaic, i.e. in which natural objects were imitated.

Mosaic Gold. Bisulphide of tin; a yellow flaky substance, sometimes employed in ornamental japan work. This term has also been applied to a superior kind of brass, and to a yellow alloy of copper, zinc, and gold. [AURUM MUSIVUM.]

Mosaic Work. In Architecture, the inlaying pavements, walls, &c. with small dies of different-coloured stones or glass, in regular figures, or to represent historical or other subjects.

saurus (Lat. Mosa, *the Meuse*, and Gr. σαῦρος, *lizard*). A large extinct Lacertian reptile which existed during the deposition of the Cretaceous strata. Its remains have been found both near Maestricht and in the cretaceous deposits in America. The concavo-convex or procœlian type of vertebræ existed in the spinal column of this extinct gigantic saurian.

Moslem. [MUSSULMAN.]

Mosque (Arab. medsched). A Mohammedan place of religious worship. The principal interior decoration of mosques consists in the lamps, which are numerous, and singularly disposed; the floor is covered with carpets: the direction of Mecca is denoted by a niche, or by a tablet inscribed with verses of the Koran, called the Kebla. The principal Arabian and Syrian mosques are most remarkable for their vast quadrangles, surrounded with numerous columns; those of the Turks for the elegance of their cupolas. The original places of worship of the Arabians were the temples dedicated to the religion of the different nations whom they subdued. It was not until they had consolidated their power that the Arabians devoted themselves to the cultivation of the arts, and gave any indication of that architectural genius which afterwards displayed itself in the structure of mosques. At the entrance of almost every mosque there is a large court planted with bushy trees, in the centre of which, or under a vestibule paved with marble, are fountains for the prescribed ablutions of the Mussulmans; and to these courts is usually attached a small gallery, on which the apartments of the ministers of religion, &c. abut. But besides mosques for public worship, there are others set apart for the instruction of young men in the science of legislation and the doctrines of the Koran; and to this class belong the so-called *royal* mosques, or *jamis*, of Constantinople. Most of these mosques have hospitals for poor, sick, or deranged persons, attached to them. Their revenues are often considerable, and are derived chiefly from endowments in landed property. The term *mosque* is found, with slight variation, in all European languages. The Turkish equivalent is supposed to be derived from the Arabic mesgiad, *a place of adoration*; and from this are derived respectively the French mosquée, the German moschee, the Spanish mequita, the Italian mascheta, and the English mosque. [MINARET.]

Mosquito. The American name for the species of gnat *Culex*. They abound in damp situations, both in the warmer climates and during the summer months in high northern latitudes. They pierce the skin with a lancetted proboscis, and discharge a venomous liquor into the wound; they can be guarded against at night by enclosing the bed with a mosquito curtain. The Laplanders drive them away by fire, and by coating the naked parts of the body with grease.

Moss Agate. The name given to those kinds of Agate which enclose dendritic or moss-like markings. They are found in large quantities at Oberstein in Saxony.

Moss Land. Land abounding in peat moss, but not so much saturated with water as to become peat bog, or morass.

Mosses (Fr. mousse, Lat. muscus, Ger. moos). In common language, mosses signify any minute, small-leaved Cryptogamic plants. But in systematical botany no plants are considered mosses, except such as belong to the natural order *Bryaceæ* or *Musci*. Such plants are simple-leaved; without spiral vessels or stomates; with a distinct axis of growth; and with the spores or reproductive matter enclosed in cases, called *sporangia* or *thecæ*, covered by a cup or calyptra. The structure of the sporangia is as complex as that of the stems and leaves is simple. Each sporangium is closed by a lid or operculum; below which is a transverse membrane, closing up the urn left after the fall of the operculum. The edge of the urn is furnished with one or more rows of teeth, in all cases some multiple of four; in the centre is a columella or column, and between the latter and the sides of the urn are the spores. It is not a little singular that such plants should have cases called *staminidia*, containing powdery matter; among which are found animalcules, not distinguishable from such as are called spermatic, and which swim about freely in water.

Moss-troopers. In English and Scottish History, those inhabitants of the borders of the respective countries who were banded together in clans and lived by rapine, received this denomination from the character of the country over which they *trooped* in their excursions. These banditti were little heard of after the union of the two crowns, but not absolutely suppressed until the union of the kingdoms a century afterwards.

Mossotite. A variety of Aragonite, found in the Lias of Gerfaleo in Tuscany.

Motazalites. [SEPARATISTS.]

Motes. Among the Anglo-Saxons, public courts or conventions of the people assembled for municipal or legislative purp[illegible] were of various kinds; as Wit[illegible] FOLKMOTE, BURGH MOTE, &c. Mote was a customary service or payment at the mote or court of the lord, from which certain persons alone were exempted by charter or other privilege.

Motet (Ital. motetto). In Music, a vocal composition, consisting of from one to eight parts, of a sacred character.

Mother Liquor or **Mother Water.** A term applied by chemists to saline solutions from which crystals have been deposited, and which, when poured off and re-evaporated, generally furnish a second crop.

Mother of Pearl (Ger. perlen-mutter, Fr. nacre de perles). The hard, silvery, brilliant internal layer of several kinds of shells, particularly oysters, which is often variegated with changing purple and azure colours. The large oysters of the Indian seas alone secrete this coat of sufficient thickness to render their shells available for the purposes of manufactures. The genus of shell fish called *Pentadinæ* furnishes the finest pearls, as well as mother of pearl; it is found in greatest perfection round the coasts of Ceylon, near Ormus in the Persian Gulf, at Cape Comorin, and among some of the Australian seas. The brilliant hues of mother of pearl do not depend upon the nature of the substance, but upon its structure. The microscopic wrinkles or furrows which run across the surface of every slice act upon the reflected light in such a way as to produce the chromatic effect; for Sir David Brewster has shown that if we take, with very fine black wax, or with the so-called fusible alloy, an impression of mother of pearl, it will possess the iridescent appearance. Mother of pearl is very delicate to work; but it may be fashioned by saws, files, and drills, with the aid sometimes of an acid, such as the dilute muriatic; it is polished by colcothar. (Ure's *Dictionary of Arts, &c.*)

Mother of Vinegar. The flocculent mycelium of various Moulds, which forms on the surface of vinegar.

Mother-cells. In Vegetable Physiology, cells in which other cells are generated.

Motion (Lat. motio). In Mechanical Philosophy, motion is change of place: i. e. of the part of space which body occupies, or in which it is extended. Motion is *real* or *absolute* when the moving body changes its place in absolute space; it is *relative* when the body changes its place only with relation to surrounding bodies; and it is *apparent* when the body changes its situation with respect to other bodies that appear to us to be at rest. All the phenomena of motion are derived by mathematical deductions from the three following *laws of motion* given by Newton in his *Principia*:—

1. A body must continue for ever in a state of rest, or of uniform motion in a straight line, if it be not disturbed by the action of an external cause.

2. Every change of motion produced by any external force is proportional to the force impressed, and in the direction of the straight line in which the force acts.

3. Action and reaction are equal and in contrary directions; that is, equal and contrary changes of motion are produced on bodies which mutually act on each other.

The term *quantity of motion* is used, by writers on mechanics, to denote the product of the mass of a body into the velocity with which it moves. It is, therefore, synonymous with *momentum*.

Motion. In Music, refers to the movement of the parts in contrapuntal writing. Direct or similar motion is when two parts move in the same direction, i. e. rise or fall together; contrary motion is when one rises and the other falls; and oblique motion is when one part moves in either direction while the other is stationary. Contrary motion is the best, and next oblique motion.

Motion. In Painting and Sculpture, the change of place or position which from certain attitudes a figure seems to be making in its representation in a picture. It can be only implied from the attitude which prepares the animal for the given change, and differs from Action [which see]. Upon motion, in art, depends that life which seems to pervade a picture when executed by a master.

Motion in Court. In Law, an occasional application to the court, by the parties or their counsel. Motions are either of a criminal nature, as motions for an attachment for a misbehaviour; or of a civil nature. A motion in the courts of common law is either for a rule absolute, i. e. to take effect immediately; or it is for what is termed a rule nisi, or a rule to show cause—i. e. a rule to take effect, unless cause be shown against it by a certain day, when, if no cause be shown, the rule is made absolute. Motions also form an important part of the practice of courts of equity. Injunctions [Injunction] are usually applied for in this manner. Motions are accompanied by affidavits stating the facts on which they are grounded, and generally preceded by a notice to the opposite party.

Motory or **Motorial.** In Physiology, this term was applied by Hartley, in 1749, to the nerves conveying the stimulus to the muscles, in contradistinction to the nerves conveying the impressions to the neural axis, which he called *sensory*; but he distinguished those actions which result from the conveyance of impressions to the brain, producing sensation and exciting volition, from those actions which are now called *reflex*; as where he states that 'the actions of sneezing, swallowing, coughing, hiccoughing, vomiting, and expelling the fæces and urine, with others of a like nature, are to be deduced from those vibrations which first ascend up the *sensory* nerves, and then are detached down the *motory* nerves, which communicate with these by some common trunk, plexus, or ganglion.'

Motto (Ital.). A term used to signify a word or sentence added to a device; when put upon a scroll, it is commonly employed as an external ornament of coat armour. The use of mottoes for this purpose is very ancient. The term *motto* is also applied to a sentence or quotation prefixed to any writing or publication.

Mould (Goth. mulda, *dust*). Soil composed of decayed vegetable matter in a state of minute division, more or less mixed with gar-

den earth. The kinds of mould most in use in horticulture are Leaf mould, formed from the decayed leaves of trees; Rich mould, formed of thoroughly decayed stable dung; Heath mould, found on the surface of heath lands; and Peat mould, formed of thoroughly decomposed peat. In general, mould is distinguished from soils by containing a much greater portion of organic than of earthy matters.

MOULD (Fr. moule; Span. molde; probably from Lat. modulus). In Sculpture, the matrix or hollowed wrought form into which the liquid or plaster, wax or metal, is run in casting works of art.

A *safe-mould* is a mould taken in many pieces from the original cast from the first mould, which is destroyed, so that it can be safely removed from the model, and be put together again, in order to produce other casts.

Mould Loft. A large room in a dockyard in which the several parts of the ship are drawn out in their proper dimensions, for the guidance of the builder.

Moulds. This name is popularly applied to the thread-like *Fungi* which prey upon our provisions, and attack such substances as gum, glue, ink, &c., living at their expense, and destroying their valuable properties. Many of the moulds, observes Mr. Berkeley, are capable of sustaining life when immersed in fluids, contrary to the habit of most *Fungi*; and from their capability of appropriating what is nutritious, and rejecting what is hurtful, they are often developed even in solutions of poisonous metallic salts, which would be fatal to *Fungi* in general. In a solution of sulphate of copper, for example, they become as it were electrotyped by the copper, while they appropriate the other elements.

As the spores are often able to sustain a considerable degree of heat without destruction, they occur in situations where they would otherwise not be expected, as in preserved fruits which have been subjected to heat, and when there could be no access of fresh spores. Where there is any possibility of communication, there are few kinds of vegetable tissues which they cannot penetrate; and in animals, they occur in situations where they must, like intestinal worms, have worked their way through the tissues to the cavities in which they grow. They are amongst the most destructive agents in the production of disease, as is proved by the potato murrain. In the human frame they are the fruitful source of cutaneous disorders. (Lindley and Moore, *Treasury of Botany*.)

Moulding (Fr. moulure). In Architecture, the various members of an order, which are shaped into various curved or flat forms, of which there are eight sorts: (1) the filet, square in profile; (2) the astragal; (3) the torus, larger than the astragal; (4) the scotia; (5) the echinus or quarter round; (6) the inverted cyma, talon, or ogee; (7) the cyma, the cyma recta, or cymatium; and (8) the cavetto or hollow.

In the Romanesque, and Teutonic or Gothic styles of architecture, mouldings are of great importance, as determining the exact stage of art to which a particular building belongs. (F. A. Paley, *Manual of Gothic Mouldings*.)

Moulting. The fall of the plumage of birds. It may be either partial or total. The complete moult generally takes place annually; the partial moult occurs at the change of plumage to which some species of birds are subject at the breeding season. The moult is always accompanied by the developement of a new plumage, which may be of a different colour from that which is lost. [INDUMENTUM.]

Mountain (La Montagne). In French History, a popular name given in 1793 to the party of extreme Jacobins in the Convention, who occupied the highest rows of seats, while the moderate men generally crowded into the lower places in the centre (thence called *plain*). As government fell more and more into the hands of these violent politicians, it became in course of time a title of honour, and (after the fall of Robespierre) of reproach.

Mountain Blue. Blue copper-ore. [CHESSYLITE.]

Mountain Cork. [ASBESTOS.]

Mountain Green. [CHRYSOCOLLA.]

Mountain Leather. A variety of Asbestos occurring in flat flexible pieces resembling leather, and of a whitish colour. It differs from common Asbestos chiefly in having the fibres interlaced instead of even and parallel.

Mountain Limestone. The rock thus named is often called the *carboniferous limestone*, but to English geologists the older name will always be interesting, as marking some of its essential peculiarities in England.

This kind of limestone is of various colours, and often so full of organic remains as to appear almost entirely made up of them, especially of fragments of encrinital columns; but sometimes scarcely an organism is to be detected, and the rock is veined and variegated with streaks of calcareous spar. Both these varieties form useful and often handsome marbles.

This rock is of further interest, as being that which in the centre and north of England is the seat of our most productive lead mines; hence it is called *metalliferous limestone.* The great patch of limestone extending from the Tweed to the Tees, bounded by the coal measures on the east, and on the west by the Cheviot Hills, is especially known as the *lead measures.* The characters of the rocks are very variable. The veins hitherto worked occupy a space of about fifteen miles north and south, and twenty west and east, and run, with little exception, nearly west and east.

The Yorkshire limestone district, exclusive of its metallic veins, is traversed by others, which, as they are only filled with non-metallic minerals, are of little interest to the miner, although of deep importance to the geologist. They intersect the metallic veins, disturbing the parallelism of the strata, and often occasioning

much irregularity and confusion. The contents of these cross-courses are very miscellaneous; and where the material with which they are filled is much harder and more durable than the regular strata, their course is often perceptible upon the weather-worn surface of the country which they traverse. Such is the cross-vein of the lead measures called the Devil's Backbone, forming a ridge that may be traced a considerable distance along the country through which it passes.

The Derbyshire limestone district is well known. Castleton is its northern point, and it extends southward about twenty-five miles to Weaver Hill. Its breadth is very irregular, but nowhere much exceeds twenty miles. At its eastern end it produces the delightful and varied scenery of Matlock, and its north-western extremity is celebrated for the wonders of the Peak.

In regard to the varied aspect of this district, it may be observed that the different strata of limestone differ considerably from each other; that beds and dikes of basalt intervene, provincially called *toadstone* (todt-stein, *dead or unproductive rock*); and lastly, that the country is traversed by great faults or dislocations.

The singular turreted and broken appearance of these limestone rocks, and the fantastic shapes which their various masses occasionally assume, are well seen in Dovedale; and some of their other peculiarities, especially their curvatures, and some of the dislocations which they have suffered, are evident in Matlock and its neighbourhood. In the High Tor the stratification appears horizontal and regular when viewed in front; but a more accurate examination shows that it is curved and irregular. An instance of curved strata may be seen in Crich Cliff, about four miles east of Matlock; it is an isolated hill about 900 feet above the level of the river. The different beds of limestone are of very different qualities and composition; the upper cherty, and often bituminous, abounding in corallines and encrinital stems, &c., often curiously seen in relief upon its weather-worn surface. Beneath the rock, beds of magnesian limestone and silicious limestone or dunstone are seen, and towards the lower part beds of black marble. The lowest limestone stratum is that which forms the Peak Forest, the downs of Buxton, and the Weaver Hills; and in it are several remarkable caverns. We find at Castleton numerous veins of fluor spar, used in the manufacture of vases, &c.; also elastic bitumen, or fossil caoutchouc. The subterranean streams which traverse many of these caverns, the stalactites and stalagmites in which they abound, and the thermal waters which characterise the district, are all important points to be noticed. The toadstone of Derbyshire is sometimes regularly stratified between the limestone beds. The toadstone never contains shells or organic remains; chalcedony, zeolite, and globules of calcareous spar are not uncommon in it. In the cave at Castleton it forms a large irregular column.

The veins of the limestone in Derbyshire contain ores of lead, manganese, copper, zinc, and iron: indeed, the proper repository of the lead appears to be the limestone, though it also occurs in some other strata, and rarely in the toadstone, in which it is always in small quantities, and merely in strings or very imperfect veins.

Near Bristol the limestone hills rise from below the new red sandstone, and from the edges of the coal basin. In some places it is very bituminous, as on the Avon at Chepstow, where it exudes petroleum. On the Welsh coast of the Bristol Channel we have another ridge of limestone, forming one side of the basin in which the great coalfield of South Wales is situated. The hills on the west of Swansea and the cliffs on the south of Pembroke are of this formation; and on the banks of the Wye it constitutes scenery of a soft but most romantic character. There is something singularly fascinating in the landscape of the limestone districts, resulting not only from the varied forms and groupings of the mountain masses, but depending also upon the nature of the substance and of the soil derived from its decay. Upon the perpendicular and projecting precipices lichens of various and singular hues alternate with the grey surface of the uncovered rock; a variety of shrubs are scattered by nature's hand upon its picturesque and waving sides; ivy and other creeping plants issue in gay luxuriance from its crevices, and the glens and valleys are adorned by every variety of verdure. [CARBONIFEROUS SYSTEM.]

Mountain Systems. In all countries the mountains are singularly influential in modifying the essential features of the land, in influencing climate, and in governing the distribution of life. There is nothing in physical geography that affords a better indication of the present condition and future capabilities of a country than its mountain and river systems.

Mountains occur usually in lines of considerable length as compared with their breadth. A mountain chain is thus a continuous series of elevated land, broken occasionally by valleys, and rising here and there into lofty peaks. When the phenomenon is on a grand scale, the chain influences greatly the geological structure; and when local, there is local geological cause.

Each great tract of the earth has its mountain system, governing its form and often marking its outline. In some countries where there are many such chains having different directions, the older mark the coasts, and the newer the central ridge. In others the coast range is the principal and more modern elevation, and determines the whole character of the interior.

The principal mountain chains of the earth are as follows, and are noticed under separate headings. In Europe and Asia, including North Africa, a vast central line of chief elevation includes the HIMALAYAN chain, the CAUCASUS, the ALPS, the ATLAS, and the PYRENEES. Somewhat subordinate to these, but still important, are the

CARPATHIANS, the BALKAN, and the APENNINES. In South Africa there is no principal mountain chain. In America there are the ANDES and the ROCKY MOUNTAINS, and the much lower, but not unimportant, chain of the APPALACHIANS.

Volcanoes do not form mountain chains, though they occasionally occur in continuous lines. Besides the continuous chains and detached volcanic mountains, there are not wanting instances of isolated mountain masses.

Many of the great mountain chains are continued beyond the coast into the ocean as submarine mountains. There can be little doubt that these phenomena mark great lines of upheaval, and are very important in reference to the earth's history.

Mourning (akin to Gael. mairgnich, *to groan*; Gr. *μεριμνᾶν, to be anxious*; Goth. maurnan: Wedgwood). Any external indication or manifestation of grief for the death of a friend or relative. Certain usages in regard to mourning have been in force among all nations from the earliest ages; but except in the grief of which they are intended to be the symbol, no customs exhibit fewer marks of uniformity. Thus, the Chinese mourn in white; the Turks in blue or in violet; the Egyptians in yellow; the Ethiopians in grey. In ancient Rome and Lacedæmon the ladies mourned in white. In Eastern countries it was regarded as a peculiar mark of affliction to cut the hair; and at Rome, on the contrary, to let it grow. The Greeks adopted the Eastern practice, and bestrewed with their hair the tombs of those for whom they mourned. The peculiarities of the ancient Jews in time of mourning are well known; and the various customs of which so minute an account is contained in the Pentateuch are still maintained on these occasions by their descendants. From the commencement of the Christian era the general colour adopted for mourning throughout Europe has been, with very few exceptions, black. The kings of France mourn in violet. The duration of the period of mourning differs in different countries, but in all is usually regulated by the nearness of relationship between the survivors and the deceased. The rules that determine the forms and duration of *court mourning* emanate from the sovereign, but do not extend beyond the court. (The art. 'Deuill,' in the *Encyclopédie des Gens du Monde*, gives a very complete view of the chief modes of mourning in use in ancient and modern times.) [SEPULTURE, RITES OF.]

Mouse. In Naval Affairs, a hump or knot worked on a rope, to prevent a noose from slipping.

MOUSE. In Zoology. [MUS.]

Mousing a Hook. Passing a piece of spun yarn round the point and back of the hook of a block, in order to prevent its disengaging itself from anything it may be hooked to.

Mouth (Ger. mund, Goth. munths). In Architecture, the same as CAVETTO [which see].

Movable Feasts. Certain festivals held in commemoration of different events recorded in the Gospels and the Acts of the Apostles. As they are reckoned backward and forward from the Resurrection, and as the celebration of that event depends on the time of new moon, which varies at different times through the space of a month, these dependent festivals also vary in the same way. Easter is always the first Sunday after the first new moon after March 21; and from this all the others are reckoned for each year.

Movement. In Politics, an expression adopted of late years into the political vocabulary of most European nations, signifying that party in a state which strives to obtain such concessions in favour of popular rights as will ultimately place the chief functions of government in the hands of the people. It is opposed to the Conservative party, or the *parti de résistance.*

Moving or Motive Force. In Mechanics, the cause of the change of velocity in the motion of a body. At any instant it is measured by the increment of momentum, referred to the unit of time, and is, therefore, expressed by $m\frac{d}{dt}=m\frac{d^2s}{dt^2}$. The unit of moving force is that which in every unit of time could impart to the unit of mass a unit of velocity. That part of the moving force which may be conceived to be acting upon each unit of mass of a moving body is often called the accelerating force.

Moxa (Fr.). There are various substances used in surgery to produce a sore by means of slow combustion. Moxa, which is one of these substances, is prepared in Japan and China from certain species of *Artemisia*, as *A. Moxa*, *A. chinensis*, &c., and consists of the downy covering of their leaves and stems.

Mozambique Current. A south-westerly current thus named sets along the African coast toward the channel of Mozambique during the whole year, and is probably the result of a drift current produced in the South Indian Ocean by the monsoons; it varies much in different seasons and years. The set of the winds drives the water up among the islands, and forces it to recover its level by rushing through the Mozambique channel.

This current is a part of the chain conveying the waters of the Pacific to the Atlantic, and is connected with the current produced within a narrow belt of ocean on the south side of the equator. On the north side the causes act less regularly, and the results are not traceable.

Mucic Acid. A crystalline acid formed by the oxidation of gum arabic, sugar of milk, and other members of the saccharine group of substances. It is a dibasic acid.

Mucivora (Lat. mucus; voro, *I devour*). A name applied to a family of Dipterous insects, comprehending those which feed on the juices of plants.

Muck, Running a. A phrase which has been adopted into the English language to signify an indiscriminate attack upon friends and enemies; as in the verse,

Who runs a muck, and tilts at all he meets.

This expression is derived from the Javan word amok, which means *to kill*; the inhabitants of Java, and many other of the Asiatic islands, being remarkable for a frenzy which leads them to aim at indiscriminate destruction. These fits of desperation were long considered peculiar to the class of slaves in the islands above mentioned; but there are many instances on record where whole villages, and even armies, have under the influence of *amok* devoted themselves to destruction to avenge an injury or an insult. The accounts of the wars of the Javans, says Raffles, in his *History of Java*, as well as of the Maláyus, abound with instances of warriors running *amok*; of combatants rushing on the enemy, committing indiscriminate slaughter, and never surrendering themselves alive. The cause of these fits of desperation has been attributed to intemperate opium-eating.

Mucous Membrane. The membranous lining of the canals and cavities of the body which are exposed to the contact of air or other inorganic substances. The basis of this membrane is compact cellular tissue, having a peculiar cuticular covering, beset in some cases with abundant nervous papillæ in others with the orifices of secretory glands.

Mucronate (Lat. mucronatus, from mucro, *a point*). In Botany, applied to any organ which is abruptly terminated by a hard sharp point.

Mucuna (Mucuna-guaca, the Brazilian name of one of the species). The genus of Leguminous plants which yields the Cowage or Cow-itch of the *Materia Medica*. The species is *M. pruriens*, a tall West Indian climber, bearing thick leathery pods, which afford the Cowage, a celebrated remedy for intestinal worms. The pods are shaped like the letter *f*, four or five inches long, and clothed with short stiff brittle brown hairs which cause intolerable itching. Their beneficial effect is attributed to the action of the irritating hairs on the worms.

Mucus (Lat.). The secretion of the mucous membranes, the most characteristic of which is that from the nasal membrane. Mucus is viscid, and acquires apparent fluidity in water, without being actually dissolved. It may be repeatedly dried and moistened without material change of properties. When boiled in water it becomes tough, but on cooling resumes its former characters. When dried, it is yellowish and translucent. It is precipitated from its aqueous mixture by acetic acid and by alcohol. Under the microscope it presents nucleated globules and epithelial scales, which vary in appearance according to the situation and functions of the particular membrane from which they have been thrown off

Mudar. The Indian name of *Calotropis gigantea*, a plant of the Asclepiadaceous order, used medicinally in the East Indies in scrofulous cases.

Muezzin. In Mohammedan countries, the general appellation of those officers, or clerks of the mosques, whose duty it is to proclaim the summons to prayers, at the five canonical hours; viz. at dawn, noon, four o'clock P. M., sunset, and nightfall.

Muffle. An arched vessel with a flat bottom, in which substances may be exposed to a red heat without coming into contact with the fuel. [ASSAYING.]

Mufti. The Turkish title of a doctor of the law of the Koran; derived from *fetvas*, a rescript or answer to a question of law addressed to the competent authority; which fetvas it is the province of the mufti to issue. The mufti of Constantinople, or Sheikh-ul-Islam, is the chief functionary of the Turkish church, and represents the sultan in spiritual matters, as the grand vizier does in temporal.

Muggletonians. A sect of Christians who sprang up in England in 1561, and derived their name from one Muggleton, a tailor, who, together with an associate called Reeves, gave themselves out as the two last and greatest prophets of Jesus Christ, and asserted that they had power to save or to ruin in a future state whomsoever they pleased. Notwithstanding the absurdity of their pretensions they obtained many adherents; and the belief in their inspiration has been maintained by a small number down to the present time. A collection of the writings of Muggleton and Reeves, together with other Muggletonian tracts, was published in 3 vols. 4to. in 1832. In the religious controversy to which the promulgation of their doctrines gave rise, their chief opponents were the Quakers, and among these were George Fox and William Penn.

Mugiloids (Lat. mugil, *a mullet*). A family of Acanthopterygian fishes in the system of Cuvier, characterised by having an almost cylindrical body covered with large scales, and furnished with two separate dorsals, the first of which has but four spinous rays. The mouth is either edentulous, or is provided with teeth of extremely minute size. This family includes the genera *Mugil*, *Tetragonurus*, and *Atherina*; it is included in the Cycloid order in the system of Agassiz.

Mulatto. A term in general use in American countries (in which there exists a mixed population of different races and colours) for the offspring of a union between a white and a negro.

In our West Indian possessions the offspring of a white and a mulatto is called a *quadroon*, or one-quarter black; of a white and quadroon a *mustee*, or one-eighth black; of a white and mustee a *mustafina*, or one-sixteenth black; after which they are said to be *whitewashed*, and are considered as Europeans. On the other hand, the offspring of a mulatto and a negro is called a *cabre*; of a cabre and negro, a *griffe*; and, generally speaking, after this there is no distinctive appellation but *negro*. All this is sufficiently simple; but in the Spanish

and Portuguese colonial possessions, the intermixture of Europeans with negroes, mulattoes, &c., and these again with other classes, has given rise to a multiplicity of denominations sufficiently vague and indefinite even in these languages, but wholly untranslatable into English. It must be admitted, however, that great ingenuity has been displayed in tracing the amount of European and negro blood that flows in the veins of the mixed races, as the following list of terms (which might be considerably augmented) will prove: Zambi, quatralvi, tresalvi, saltatras, coyote, zambaigi, cambusos, jiveros, puchuelas, albarassados, barrinos, &c. All these again may be multiplied in arithmetical progression, thus forming a host of modifications, each, however, retaining more or less his original characteristics in proportion to the relation in which he stands to his original stock.

In Spain, the term *mulatto* has been employed to designate persons having a tincture of Moorish blood.

Mulberry (Ger. maulbeere, Lat. morus, Gr. μόρος). The fruit of the *Morus nigra* and *Morus alba*. The so-called Paper Mulberry is the *Broussonetia papyrifera*; its tenacious pliable inner bark furnishes a valuable material for the dress of the South Sea Islanders and Chinese. [Morus.]

Mulberry Calculus. A urinary concretion, consisting chiefly or entirely of oxalate of lime. Many of these calculi in form and colour somewhat resemble the fruit of the mulberry. [Urine.]

Mulch (Dutch molsch, akin to Latin mollio and mulceo, &c.). Straw or litter half rotten. In Horticulture, when this material is applied round the roots or stems of plants to protect them from the drought or from frost, they are said to be mulched.

Mule. A machine for spinning cotton. This very ingenious piece of mechanism was invented, about the year 1777, by Samuel Crompton, formerly of Hall-in-the-Wood, Lancashire. For many years the machine was worked by hand only, the variety of its movements rendering it difficult to accomplish the moving of it by the power of water or of steam so simply as to be of common use. (Buchanan's *Essays on Mill-work* 1841.)

Mule. In Botany. [Hybrid.]

Mule (Lat. mulus). In Zoology, the hybrid between the jackass and the mare: the hybrid between the stallion and the female ass being termed *hinny*. In most cases, the progeny either of mules inter se or with the parent stock is unfruitful, but a few instances in which progeny has been perpetuated have been observed. The Spanish mules are the progeny, on the sire's side, of a breed of asses far more strong and graceful than those existing in England. [Hybrid.]

Mull. A term used in Scotland almost synonymous with Cape; and applied to various projecting portions of the island, as the Mull of Galloway, of Cantyre, &c.

Mullas. The priests of Tartary are so called. They form one of the three grand classes into which the Tartars are divided; the other two being the *murzas* or nobility, and the peasantry. Their chief duty consists in reading the Koran; but their stock of knowledge is generally so scanty, that they are seldom able to interpret the Arabic in which the office of the mosque is performed. The village mullas are generally decently behaved and respectable men; 'a little too much given to sell charms for the ague, but living for the most part among their neighbours a quiet and charitable life, the arbitrators as well as curates of their sequestered valleys; and frequently possessing, in addition to these weighty charges, the sinecure office of parish schoolmaster.' (*Quart. Rev.* vol. xxix. p. 129.) The Tartar *mulla* and the Persian Mollah [which see] have evidently a common origin; but their rank and offices are distinct.

Mullein. The common name for the species of *Verbascum*, of which several occur wild in this country.

Mullet (Fr. molette). In Heraldry, this term denotes the rowel of a spur. In English blazonry it is depicted of five points: in French of six. It is used as the filial distinction of the third son. [Difference.]

Mullet (Lat. mullus, Gr. μύλλος, although the same word did not denote the same fish). The name of the fishes of the genus *Mugil*, which, in addition to the family characters of the Mugiloids, have the middle of the under jaw produced into an elevated angular point, adapted, when the mouth is closed, to a corresponding groove in the upper jaw; the number of the branchiostegous rays is six. Of this genus there are three British species; viz. the grey mullet (*Mugil Capito*, Cuv.); the thick-lipped mullet (*Mugil Chelo*, Cuv.); and the short mullet (*Mugil curtus*, Yarrell); of these the first species is the least rare. The red mullets (*Mullus Surmuletus*, Cuv.; and *Mullus barbatus*, Linn.) belong to a different family of fishes: the former of these species were the fish so greatly esteemed by the ancient Romans, and for which extravagant prices were given when it had attained an unusually large size.

Mullicite. A native phosphate of iron (Vivianite) found at Mullica Hill, New Jersey.

Mullion. In Architecture, the upright post or bar dividing two lights of a window.

Multiarticulate (Lat. multus, *many*; articulus, *a joint*). In Zoology, a term applied to the antennæ of insects, and to the legs of crustaceans and cirripeds, when they are composed of a great number of joints; also to bivalve shells which have numerous teeth in the hinge.

Multicarinate (Lat. multus; carina, *a keel*). In Conchology, a term applied to a shell which is traversed by many keel-like ridges; as the *Fusus multicarinatus*, *Terebratula multicarinata*.

Multidentate (Lat. multus; dens, *a tooth*). In Zoology, when a part is armed with many teeth or tooth-like processes. A family of

Nereids is hence termed *Multidentate* by De Blainville, on account of the structure of their horny jaws.

Multilocular (Lat. multus; loculus, *a case* or *coffer*). In Botany, a term applied to capsules or ovaries which have many cells.

MULTILOCULAR. In Conchology, this term is applied to those shells which, like the nautilus, have their cavity divided into many chambers.

Multinomial (Lat. multus; nomen, *name*). In Algebra, an expression consisting of more than two terms, which are connected by the signs of addition or subtraction, + or −. Sometimes it is called a *polynomial*; and in modern works, after the French writers, a *polynome*.

Multinomial Theorem. A theorem discovered by De Moivre for forming the numeral coefficients which arise in raising any multinomial to any given power without the trouble of actual involution. The binomial theorem of Newton is a particular case of this; viz. that in which the number of terms is only two.

It may easily be seen that each term in the expansion of $(x_1 + x_2 + \ldots + x_n)^m$ will be of the form $C x_1^{a_1} x_2^{a_2} x_3^{a_3} \ldots x_n^{a_n}$, where C is a numerical coefficient, and the exponents may have all possible values, zeros included, subject to the condition $a_1 + a_2 + \ldots a_n = m$. There will consequently be

$$\frac{n(n+1)\ldots(n+m-1)}{1,\ 2,\ 3\ \ldots\ldots\ m}$$

terms in the expansion, this being the number of combinations, allowing repetitions, of n things taken m at a time. [COMBINATIONS.] The coefficient C will be equal to the number of different permutations of n letters of which a_1 are of one kind, a_2 of another, a_3 of a third, and so on; hence

$$C = \frac{\underline{n|}}{\underline{a_1|}\ \underline{a_2|}\ \underline{a_3|}\ \ldots\ldots\ \underline{a_n|}}$$

[PERMUTATIONS.] This is also the numerical coefficient which must be prefixed to the term

$$x_1^{a_1}\, x_2^{a_2} \ldots x_n^{a_n},$$

in the quantic or homogeneous function which Prof. Cayley represents by

$$(*\between x_1,\ x_2,\ \ldots x_n)^m.$$

[QUANTIC.]

Multiple (Lat. multiplex). Any quantity which contains another an exact number of times without a remainder is a *multiple* of the latter, and the latter is a *submultiple* or part of the former.

Multiple Integral. The result of successive integrations. Thus the function of x whose n^{th} differential coefficient is a given function X, would be called a multiple integral of the n^{th} order, and denoted by

$$\iint \ldots X\, dx^n \quad \text{or} \quad \left(\frac{d}{dx}\right)^{-n} X.$$

Again, if u were a function of n independent variables $x_1, x_2 \ldots x_n$, the function U whose n^{th} partial differential coefficient

$$\frac{d^n U}{dx_1\, dx_2 \ldots dx_n} = u$$

would also be termed a multiple integral, and denoted by

$$\iiint \ldots u\, dx_1\, dx_2 \ldots dx_n.$$

In effecting the integration according to x_n, the other variables must, of course, be regarded as constants, and the integral completed, accordingly, by the addition of an arbitrary function of these variables, before proceeding to the next integration, and so on. In the case of definite integration these arbitrary functions are determined at each successive step. In applications of the calculus we are concerned principally with definite *double* and *triple integrals*. In geometry, for example, we meet with such integrals in problems on the quadrature of surfaces, and cubature of solids. Thus the double integral

$$\iint F(x, y)\, dx\, dy,$$

would represent the quadrature of a surface if $F(x, y)$ denoted the reciprocal of the cosine of the angle betwen the axis of z and the normal at the point x, y, z. The same integral also represents the volume of the space enclosed between a surface, having $z = F(xy)$ for its equation, the plane of $x\,y$, and a certain cylindrical surface with generators parallel to the axis of z.

In evaluating multiple integrals much depends upon a suitable choice of coordinates, and it is frequently necessary to transform the variables before attempting the integration. This is done by means of the following formula: If x and y are each replaced by functions of two new variables u and v, then $dx\, dy$ must be replaced by J $du\, dv$, where J is the *Jacobian*

$$\begin{vmatrix} \frac{dx}{du} & \frac{dy}{dv} \\ \frac{dx}{du} & \frac{dy}{dv} \end{vmatrix}$$

A similar theorem holds for triple integrals. After transformation, the new limits, of course, require careful determination.

Multiple Point on a Curve. A point through which the curve passes several times. For instance, if every line drawn through a point m on a curve meet the latter in r points coincident with m, then m will be a *multiple point of the r^{th} order of multiplicity*; thus if, in general, u_k represent a homogeneous function of the k^{th} order in the Cartesian coordinates x, y, the origin will be a multiple point of the r^{th} order on the curve whose equation is

$$u_r + u_{r+1} + \&c. \ldots = 0.$$

Of the infinite number of lines drawn through such a multiple point, r, at most, will meet the curve in $r + 1$ coincident points; these will be

the tangents to the r branches of the curve which pass through the multiple point, which latter will be characterised by the number of these tangents which are real or imaginary, distinct or coincident. [DOUBLE, CONJUGATE, AND STATIONARY POINTS.] A curve of the n^{th} order will in general possess no multiple points whatever, and should it do so, in exceptional cases, there will be limits to their number as well as to their order of multiplicity. Thus a curve of the n^{th} order possessing a multiple point of the n^{th} order must necessarily consist of a system of right lines through a point; for if the line joining the multiple point with any other on the curve did not lie wholly in the curve, we should have the anomaly of $n + 1$ intersections of a curve of the n^{th} order by a right line. Similarly a *proper* curve of the n^{th} order having a multiple point of the order $n - 1$ can possess no other multiple point elsewhere, for the right line joining the two would, in such a case, meet the curve in more than n points. In short, it can easily be shown that to demand that a given point shall be a multiple point of the r^{th} order on any curve is equivalent to the imposition of $\frac{r(r+1)}{2}$ conditions. The existence of multiple points has the effect of diminishing the class of the curve, or, what is the same thing, the degree of its reciprocal, and in estimating this effect a multiple point of the order r may be regarded as equivalent to $\frac{r(r-1)}{2}$ double points. [SINGULARITIES OF A CURVE.]

Methods of finding multiple points are given in most treatises on the Differential Calculus. They can, however, be frequently detected at once from the form of the equation of the curve. (Salmon's *Higher Plane Curves.*)

A *multiple point on a surface* has a similar definition; every right line through it there meets the surface in several coincident points, the number of which determines the order of multiplicity. Such points are sometimes called *conical points.* [CONICAL POINT; DOUBLE POINT, &c.]

Multiple Tangent of a Curve. A line which touches that curve several times. Thus if of the several tangents which can be drawn to the curve from any point of a line, r always coincide with the line itself, the latter will be a multiple *tangent of the r^{th} order of multiplicity.* Of the r points of contact of such a tangent some may be imaginary or coincident, and the nature of the multiple tangent will vary accordingly. To a multiple tangent on a curve corresponds, of course, a multiple point on its reciprocal, so that the theories of both are intimately connected. [MULTIPLE POINT; DOUBLE TANGENT, &c.]

Multiple Tangent Line of a Surface. A line which touches the latter several times. [DOUBLE AND TRIPLE TANGENT LINES.]

Multiple Tangent Plane of a Surface. A plane which touches the surface in more than one point; the number of points of contact determines the *order of multiplicity.* [DOUBLE AND TRIPLE TANGENT PLANES.]

Multiplicand. In Multiplication, the number or quantity that is to be repeated the number of times denoted by the multiplier.

Multiplication. In Arithmetic, an abbreviated method of adding together several equal numbers. The result is termed the *product,* any one of the equal numbers is called the *multiplicand,* and the number which indicates how many of the equal numbers are to be added is called the *multiplier.*

Multispiral (Lat. multus; spira, Gr. σπεῖρα, *a spiral turn*). In Conchology, this term is applied to those opercula of univalve shells which exhibit very numerous and narrow spiral coils round a submedian centre.

Multistriate (Lat. multus; stria, *a streak*). In Zoology, when an animal or part is marked with many streaks.

Multivalve (Lat. multus; valva, *a valve*). In Conchology, when a shell consists of several calcareous pieces; as that of the chiton or barnacle.

Multoca. The name given to the code of laws by which the Turkish empire is governed; consisting of the precepts contained in the Koran, the oral injunctions of Mohammed, and the decisions of the early caliphs and doctors. It relates to every subject of life, and comprises various matters appertaining to government, the sultan being the sole judge of its application to particular cases. [SULTAN; VIZIR.] (*Edinburgh Review,* vol. x. p. 259.)

Multungulate (Lat. multus; ungula, *a hoof*). In Mammalogy, when a quadruped has the hoof divided into more than two parts corresponding with three or more digits; as the elephant, rhinoceros, &c. Ray so denominated a family of hoofed quadrupeds corresponding with the *Polyschidæ* of Aristotle.

Multure. In Scotch Law, the toll or emolument given to the proprietor of a mill for grinding corn.

Mum (Ger. mumme). A malt liquor made chiefly at Brunswick of the malt of wheat, with the addition of a little oat and bean meal.

Mumia Mineralis. A bituminous substance resembling brown asphalt.

Mummiform. In Entomology, the nymphs of certain Lepidoptera are so called which resemble an Egyptian mummy.

Mummy (Arab. mumia, from mum, *wax*). The name given to dead bodies preserved in a dry state from putrefaction. Mummies have been divided into two classes—natural and artificial; the former arising from peculiar conditions of soil and atmosphere, which permit of the drying of the animal tissues; the latter embracing the various means that have been employed to preserve dead bodies from corruption. Of the former or natural class of mummies, instances are to be found in the vaults of several Continental churches, particularly at Strasburg, Toulouse, and Bordeaux.

The art of embalming owes its origin to the

veneration with which the ancient Egyptians regarded the corpses of their relatives and of the animals which their religion held sacred; of these upwards of fifty different species have been found embalmed. The art was practised also by the ancient Jews, Greeks, and Romans, though it never attained such perfection among them as among the people from whom it was borrowed. It was also adopted as a national custom by the Guanches, the ancient inhabitants of the Canary Islands; a full account of which is to be found in the *Essai sur les Isles Fortunées*, by M. Bory de St Vincent.

The account which Herodotus has left us of the Egyptian process of embalming has been amply confirmed in all essential particulars, not only by subsequent ancient writers, but in still more recent times (see the *Memoir* of M. de Rouyer). According to this account, there were three processes employed by the professional embalmers. In the most costly method, the brain was extracted through the nostrils by a hooked iron instrument, as well as by the infusion of drugs. The viscera were then removed through an incision in the side; and the belly, having been filled with myrrh, cassia, and odoriferous herbs, was sewn up. The corpse, rubbed with natron, was then buried for seventy days, at the end of which time it was smeared over with gum, and restored to those who brought it. The second method consisted in filling the intestines with cedar oil, without any extraction of the viscera: the oil, having been kept in the body for some time, brought away with it, when drawn off, all the bowels and viscera in a fluid state, while the natron destroyed the flesh, leaving only the skin and the bones. In the third mode of embalming, for the poor, a mixture of salt and water was injected into the body, which was then wrapped up in natron.

It was long a matter of uncertainty what became of the intestines after they had been removed from the body of those embalmed according to the first process. Porphyry and Plutarch have both asserted that they were thrown into the Nile; but modern discoveries in the tombs leave no doubt of the fact that they were embalmed separately, and deposited in four vases in the coffin. (Sir G. Wilkinson's *Manners and Customs of the Ancient Egyptians*, vol. ii. p. 467, second series.)

Diodorus mentions three different classes of persons who assisted in preparing the body for the funeral: the scribe, who regulated the incision in the side; the *paraschistes*, or cutter; and the embalmers. To these may be added the undertakers, who wrapped the body in bandages, and who had workmen in their employment to make the cases in which it was deposited. Many different trades and branches of art were constantly called upon to supply the undertakers with things required for funereal purposes: as the painters of mummy cases; those who made images of stone, porcelain, wood, and other materials; the manufacturers of alabaster, earthenware, and bronze vases; those who worked in ivory; the leather cutters, and many others.

It appears that the early Christians embalmed their dead, and, according to St. Augustine, mummies were made in his time, at the end of the fifth century. But it is probable that at the period of the Roman invasion of Egypt the custom was on the decline; and Sir G. Wilkinson maintains that in all probability it fell gradually into disuse, rather than that it was suddenly abandoned from any accidental cause connected with change of custom, or from religious scruples.

Mumps (Dutch mumms). This term is generally applied to inflammation of the parotid glands. It is seldom attended by much fever or constitutional symptoms, but is occasionally translated to other glandular parts. A gentle dose of physic, and the application of a piece of flannel dipped in warm salt water or in solution of acetate of ammonia, is generally all the treatment required. From the way in which this complaint sometimes spreads in families or schools, there is some reason to believe it to be contagious. It sometimes appears epidemically.

Mundic. A Cornish mining term for Iron Pyrites.

Mundificant (Lat. mundare, *to cleanse*). A term applied in old Pharmacy to certain healing and cleansing ointments and plasters.

Mungo. A term applied to woollen cloth manufactured from old wool obtained from the rags of hard fabrics, the rags being torn into fibre by cylindrical machines armed with teeth. This cloth gives substance and warmth, and is capable of a fine finish, but from the shortness of the fibre is weak and tender. It is chiefly used for paddings, linings, office coats, druggets and blankets. Broadcloth is sometimes made with a large admixture of this cheap and inferior material. [Shoddy.]

Municipality. The word *municeps*, in the language of early Roman jurisprudence, signified a person capable of holding an office or dignity (from munus, *an office*, and capio, *I take*). It was appropriated in its more particular meaning to those who, by the constitution of Rome, were admissible to certain privileges and honours, but not to the right of suffrage or magistracy, in consequence of not being full citizens. These were the strangers who in various ways became incorporated with the Roman people without acquiring the right of citizenship. The jurisconsult Paulus (as cited by Festus) notices three sorts of municipes: 1. Free strangers settled in Rome; 2. Citizens of commonwealths which became absorbed in that of Rome by conquest or submission (quarum civitas universa in civitatem Romanam venit): such were Aricia, Cære, Anagnia; 3. Citizens of allied commonwealths, who retained their citizenship at home while at the same time they became municipes of Rome: such were Tibur, Pisa, Arpinum. It is plain that this last is the sense in which the citizen of one state was

said to be municeps of another. Towns of the last two kinds (if the passage of Paulus is correctly understood) were probably comprehended by the Romans under the title of *municipia*; i. e. towns which possessed their own rights, and the burgesses of which were also municipes of Rome. Such burgesses often acquired full Roman citizenship and even dignity, but seem to have been always (in the republican times) regarded as of recent and comparatively ignoble franchise: as in the passage of Juvenal respecting Cicero (ignobilis et modo Romæ municipalis eques); i. e. one coming from the municipium of Arpinum. By later writers, municipia are sometimes confounded with colonies. The word *municipal* and its derivatives have passed into modern usage in two different senses: 1. The local government of a small district, especially of a town, and particularly if elective, is termed a municipality: such are municipal corporations in England; 2. Every Latin municipium had its own customary law (jus municipale). Hence with later jurists municipal law came to signify the law of particular towns, districts, and provinces. In this latter sense the customs of the French cities and provinces were called *municipal laws*. Among modern publicists the word has received a still greater extension; the positive law of a country (in opposition both to natural or moral law and to the law of nations) being often called its municipal law. The same term is also sometimes used rather vaguely in contradistinction to the constitutional or political law of a state; as where crimes are divided into offences against the state and municipal offences.

Muniments (Lat. munimentum, from munio, *I fortify*, as serving to defend the title). A common name, in Legal phraseology, for deeds, charters, and other instruments evidencing the title to landed property: great landowners have generally a *muniment room* in which these are kept.

Munjeet. Indian madder, the produce of *Rubia cordifolia*.

Muntjaks. In Zoology, a subgenus, *Cervulus*, of stags, distinguished by having the horns supported on bony pinnacles; they are found in the Asiatic Archipelago.

Muntz's Metal. An alloy of copper and zinc, used for the sheathing of ships, composed of 60 per cent. of copper and 40 of zinc. It admits of hot rolling.

Murænoids (Lat. muræna, *a species of eel*). The name of a family of Apodal fishes, including the true eels (*Anguilla*) and the eels without pectoral fins (*Muræna*). The fishes of the latter genus are more voracious, and have their jaws armed with more formidable teeth than the *Anguillæ*. One species (*Muræna Helena*) was much esteemed by the ancients, who fattened it in ponds expressly constructed for the purpose.

Mural Circle or Mural Arc or Quadrant. In Astronomy, an instrument, generally of large size, attached to a stone wall or pier of solid masonry, and fixed in the meridian for the purpose of measuring the distances of stars from the pole or the zenith. The first mural quadrant, or rather arc, used at Greenwich, was erected by Flamsteed in 1689, and divided by Abraham Sharp. There are still two quadrants in the Observatory, each about eight feet radius; one of them was erected by Graham in 1725, for the observations of Halley, and was redivided by Bird in 1753; the other was constructed by Bird in 1750, and is the instrument with which Bradley and Maskelyne made their most important observations. Experience having shown that entire circles are susceptible of much more accurate division, and are much less liable to derangement than quadrants, a mural circle was constructed by Troughton, and placed in the Observatory in 1812. Since that time the advantages of this construction have been fully appreciated; and a mural circle is now regarded as the principal fixed instrument in all the great public observatories.

Troughton's mural circle is six feet in diameter. It is formed of brass, and fixed by means of sixteen conical radii, concentric to and at right angles with a conical axis nearly four feet long, seven inches in diameter at the extremity at which the circle is fixed, but only half as much at the other extremity. The axis rests and turns in two collars, one towards each end of the cone, fixed at the front and back of a stone pier about four feet in depth. The degrees are cut into five spaces, on a narrow ring of white metal composed of gold and palladium. The divisions are read by six micrometers, placed at equal distances round the circle, and securely fixed to the stone pier. The telescope is fixed at right angles to an axis which works within the conical axis of the circle. It consequently moves in the plane of the circle, and can be clamped in any position, so that the readings may be made on different parts of the circle. In order that the circle may move easily round its axis, and that the lower side of the front socket may be relieved from the load of the instrument, two large friction wheels are suspended in front of the pier from the arms of two levers, which, by means of counterpoises, may be made to support the whole or any part of the weight. The details of construction, however, admit of being varied in many different ways.

The use of the mural circle is to measure angular distances in the meridian. The axis must therefore be placed exactly horizontal, and the plane of the circle vertical and in the meridian, and the line of sight at right angles to the axis and parallel to the plane of the circle. Small errors, however, in the adjustments scarcely affect the results. The advantages of the mural above all other astronomical circles consist in the permanence of the microscopes, and the facilities for observing stars by reflection. (For a detailed description of this instrument, see Pearson's *Practical Astronomy*; also Dr. Robinson's 'Description of the Mural Circle of the Armagh Observatory,' in vol. ix

of the *Memoirs of the Royal Astronomical Society*.)

Murchisonite. A variety of Felspar, of a golden or red and yellow colour, found in the Isle of Arran, and in rolled pebbles, at Dawlish and at Heavitree near Exeter. It is named after the discoverer, Sir Roderick I. Murchison.

Murder. In English Law, the killing any person under the king's peace, with malice prepense or aforethought, either express or implied by law. The word is of the same origin with the German *mord*, French *meurtre*; in law Latin, *murdrare*, which word was, before 4 Geo. II., when legal proceedings were in Latin, an essential term of art, so that *murderavit* instead of *murdravit* vitiated an indictment. (2 Hale 187.) The malice prepense is the chief characteristic which distinguishes murder from other species of homicide; and it is the great office of the jury to determine whether or not such malice has been shown: either express, as evinced by outward circumstances; or *implied*, as where one deliberately kills another without provocation the law implies malice. Malice is also *implied* where persons having authority to arrest or imprison, using the proper means for that purpose, are resisted in so doing, and killed, which offence is murder. Killing in the prosecution of an unlawful act, when the act is done deliberately and with intention of mischief either indiscriminately or to particular individuals, is likewise murder, whether or not there was a premeditated design of killing the individual slain. So where particular malice against an individual is wreaked, by mistake, against another. Whenever, also, death ensues on an unlawful act done in prosecution of a *felonious* intention, it is murder; as where a man is killed by a shot discharged at an animal with intent to kill and steal it; or where the intent is only to do some great bodily harm, and death ensues. When several assemble to commit a breach of the peace forcefully, and happen to kill a man in the prosecution of such intention, they are all guilty of murder. In some cases, also, murder may be the consequence of a lawful act criminally or improperly performed, as by duress in a gaol.

The execution in cases of murder, by 25 Geo. II. c. 37, was to take place the next day but one after sentence, unless stayed by the discretion of the judge; with an exception for Sunday, by 9 Geo. IV. c. 31: and it was usual to sentence on Friday, in order that the Sunday might intervene before execution. But, in 1836, by 6 & 7 Wm. IV. c. 30 the time before execution was made the same as in other capital offences. (See now 24 & 25 Vict. c. 100.)

By the French code pénal of 1810, the several kinds of homicide are accurately defined; and the crimes of assassinat, parricide, infanticide, and empoisonnement are capital. But the power given to the jury by the code of 1808, of pronouncing *under what circumstances* a criminal act has been committed, materially modifies the severity of the law. If extenuating circumstances are found by the jury, the punishment is diminished.

Murex (Lat. *a shell-fish*). A name applied by Linnæus to a genus of *Vermes Testaceæ* having a univalve spiral shell, with an oval aperture ending in an entire, straight, or slightly ascending canal. The Molluscs thus characterised form a family (*Muricidæ* or rock-shells) in the order of Prosobranchiate Gastropods of the system of Woodward, and include the following genera: *Murex, Pisania, Ranella, Triton, Fasciolaria, Turbinella, Cancellaria, Trichotropis, Pyrula, Fusus*. The celebrated Tyrian purple dye was obtained from two little shell-fish, the *Buccinum* and *Murex*, the former being found on rocks near the shore, and the latter in deeper water on the Phœnician coast.

Murexan. The *purpuric acid* of Dr. Prout. Its formula is $C_6H_4O_5N_2$.

Murexide (Lat. *Murex*). The *purpurate of ammonia* of Dr. Prout. It is best obtained by adding four grains of alloxan, and seven of alloxantine, dissolved in half an ounce of boiling water, to one-sixth of an ounce of a saturated solution of carbonate of ammonia. The liquor acquires a magnificent purple colour, and deposits small crystals of murexide, which are green, and iridescent by reflected light, but deep red by transmitted light: they form a beautiful microscopic object. The chemical formula of murexide is $C_{12}H_6O_8N_5$. Murexide has been successfully used as a dyeing material. [URIC ACID.]

Muriacite. A mineralogical synonym for Anhydrite (anhydrous sulphate of lime) when it contains common salt, with which it is frequently associated.

Muriatic Acid or Hydrochloric Acid. This acid was discovered by Glauber, and called by him *spirit of salt*. In its pure or gaseous form it was first obtained by Priestley in 1774; its composition was shown by Davy in 1809, who proved it to be a compound of hydrogen and chlorine. It is procured in the gaseous state, by acting upon common salt (chloride of sodium) by sulphuric acid; the water of the acid is decomposed, and its hydrogen combines with the chlorine of the salt to form hydrochloric acid; whilst the oxygen is transferred to the sodium, which is thus converted into soda, and this unites to the sulphuric acid to form sulphate of soda. 59 parts of common salt, and 49 parts of concentrated sulphuric acid, afford, by their mutual action, 37 parts of muriatic acid, and 71 of sulphate of soda. This acid may also be formed by passing an electric spark through a mixture of equal volumes of chlorine and hydrogen; or by exposing such mixture to the sun's rays, or inflaming them by a taper, they burn with explosion, and form a volume of the acid equal to the united volumes of the gases. As the specific gravity of hydrogen is to that of chlorine as 1 to 36, the specific gravity of the resulting hydrochloric acid gas compared

with hydrogen will be 18·5, and 100 cubic inches of it will weigh 39·5 grains. Hydrochloric gas is rendered liquid under a pressure of 40 atmospheres at the temperature of 50°; it extinguishes flame, and is intensely sour, powerfully reddening vegetable blues. Water absorbs it with much violence, taking up about 480 times its volume. This is the state in which this acid is generally used. Its specific gravity is about 1·19, and it is commonly obtained by distilling a mixture of equal weights of salt, sulphuric acid, and water. When hydrochloric acid acts upon metallic oxides, a mutual decomposition of the oxide and acid generally ensues; the oxygen of the oxide unites to the hydrogen of the acid to form water, and the metal to the chlorine to form a metallic chloride. Thus it is that soda and hydrochloric acid form chloride of sodium. The most effective test of the presence of hydrochloric acid is nitrate of silver, which forms an insoluble chloride of silver in solutions containing it.

Muricate (Lat. muricatus, *pointed like the murex*). In Zoology, where a surface is armed with short, but not close-set cones, having a sharp apex.

Muridæ (Lat. mus, *a mouse*). The family of Rodents, of which the genus *Mus* is the type: by some naturalists it is restricted to the genera *Mus, Hesperomys, Dendromys, Sminthus, Perognathus, Cricetus, Gerbillus, Hydromys, Hapalotis*, and *Pseudomys*; by other naturalists it is extended to include the *Jerboidæ, Myoxidæ, and Castoridæ*.

Murines (Lat. mus). The name of a tribe of Rodent quadrupeds, of which the genus *Mus* is the type: it includes the families *Muridæ, Arvicolidæ*, and *Sciuridæ*, and is the most widely distributed of all the Rodent tribes.

Muromontite. A variety of Allanite found in black grains at Mauersberg and Boden in the Saxon Erzgebirge.

Murrain (Fr.). The popular term applied to various malignant diseases to which cattle are subject, and which have at various times made terrible havoc among them.

Thus a disease raged extensively on the Continent from 1710 to 1746. (Lancisi, *Disputatio Historica de Bovilla Peste.*) During that period many written descriptions were produced of this pest, among which the work of Sauvages, the celebrated professor of medicine at Montpelier, stands pre-eminent. The disease produced in 1757 a great fatality among the cattle of this country; and an account of this malady was published in an excellent work by Dr. Layard, a physician of London.

The murrain, as commonly met with in England, may be characterised as an extremely malignant inflammatory œdema, attacking, and indeed confining itself for the most part to one of the hind quarters of the animal. It is most common in the seasons of spring and autumn, and affects principally young cattle. The most prominent features are tumefaction and a discolouring of the side affected, with consequent lameness and inability to move; emphysema of different parts of the body, but particularly over the region of the spine; and all the symptoms of putrid fever present in diseases of a typhoid character. It speedily runs on to gangrene, and few animals survive an attack of this kind more than ten or a dozen hours.

Although this English murrain is somewhat modified in its virulence by season, locality, and the condition of the sufferer, it is nevertheless generally looked upon as incurable. It affects chiefly young animals in good condition at changes of food in spring and autumn.

Another murrain is the so-called pleuropneumonia, an inflammation of the lungs and of the membrane surrounding them, which first became contagious in this country in 1840, and has since, at intervals, destroyed great numbers of cattle in the dairy districts. Then there is the so-called foot and mouth disease, another epizootic which has done mischief enough (without being erally fatal) to deserve the name of murrain. Lastly, we have had since midsummer (1865) the Siberian rinderpest, or true cattle murrain, often destroying whole herds. It is apparently a typhoid fever, producing characteristic eruptive blotches and abscesses in the intestinal canal, and resulting in death after a few days, during which there is a mucous discharge from the nose and eyes, fœtor of breath, ulceration of palate, and profuse diarrhœa.

In its attempts to deal with this terrible disease, the veterinary science of the day has shown itself almost powerless. The variety of remedies applied, and the singular conflict of opinions on the efficacy of those remedies, prove at least the absence of all systematic attempts to record and classify the symptoms of the malady as from time to time it has made its appearance. From the vivid description given by Virgil in the third *Georgic*, it would seem that the epidemic which ravaged Northern Italy in his day much resembled the present cattle plague; and for at least seventeen years during the last century the effects of the same or a like disease were felt in this country. Yet it has been not unjustly said that 'there seems to be hardly a thread of experience to be disentangled from the story of those ravages which might form a clue to our present difficulty.' The one authoritative remedy at present is the slaughter of the herd in which a single tainted animal is found—course which savours strongly of panic, and protects, or seeks to protect, the community at the expense or even by the ruin of the owners of diseased herds. Such a system not only casts a grave reflection on the veterinary science of the time, but tends to excite a spirit of panic, which may cause serious mischief during future epidemics among human beings. It can scarcely be considered safe or prudent to adopt a course which 'resembles those savage instincts of the lower creatures, according to which a sick bird is pecked to death, and a maimed wolf torn to pieces by the

pack;' and it may be remarked that all competent medical writers on the subject agree in denying that the disease is incurable, and in condemning the method of indiscriminate massacre.

It is possible that observations of the symptoms of the present disease may lay the foundation for a real veterinary science; but, for the present, the prevention of the malady is more important than the question of medical treatment, and, like that of all other infectious diseases, consists in carefully secluding the herd from contact with diseased animals, and in allowing free access of air to all buildings, stalls, &c., with daily fumigation of them by proper disinfectants. Care should be taken to examine three or four times a day the cattle on every farm, so as to remove the healthy animals as soon as possible from those that are affected. In other words, ventilation and cleanliness are found to be as indispensable for the health attle as for that of men.

Murrhine (Lat. murrhina vasa, from Gr. *μοῤῥία*). The material of the murrhine vases, often mentioned by writers of the Roman empire, has been a subject of much dispute among modern antiquaries. The vases came from the East, and, according to Pliny, were made of some precious stone found chiefly in Parthia; but some have conjectured that this was an erroneous opinion prevalent among the Romans, and that they were in reality of porcelain, of which the manufacture was unknown to the Western nations. (Plin. *Hist. Nat.* l. 37; see also a memoir in the 43rd vol. of the *Mém. de l'Acad. des Inscr.*; and Maurice's *Indian Antiquities*, vol. vii.)

Murry or Sanguine. In Heraldry, a dark red; one of the colours or tinctures employed in blazonry, expressed in engraving by opposite diagonal lines crossing each other. It is reckoned a dishonourable colour, and is rarely to be met with in English coats of arms.

Murzas. The name given to the hereditary nobility of the Tartars, or, more strictly perhaps, to the second class of their nobility; the first or principal class being designated *beys*. This titular appellation is also sometimes conferred on the descendants of public officers; but the latter are looked upon as upstarts by the older nobility, and regarded as an inferior race. The Murzas have from the earliest ages been distinguished for their bold and refractory character; and the privileges which they formerly possessed supplied them with the means of giving effect to their turbulent dispositions. Since the conquest of Tartary, they have sunk into comparative insignificance; though many of them retain a large share of their former property, and have considerable influence among their own countrymen. (*Quart. Rev.* vol. xxix. p. 128.) The Tartar *murza* is evidently of the same origin with the Persian *mirza*; with which, however, it must not be confounded. [MIRZA.]

Mus (Lat.). A genus of Rodent Mammalia, comprising many species, which are found in nearly every part of the world. The most familiar examples are the Norway or Common Rat (*Mus decumanus*), the Black Rat (*Mus Rattus*), the Mouse (*M. musculus*), the Long-tailed Field-mouse (*M. agrestis*), the Harvest Mouse (*M. messorius*), and the Wood-mouse (*M. sylvaticus*). These species are found in great numbers, and will devour food of almost every sort. The *M. giganteus* of Hardwicke, found in Southern India, weighs more then two and a half pounds, and measures more than two feet in length. This species happily has not, like the Brown Rat, been introduced into Europe. The latter species has completely extirpated its predecessor, the black rat, in many of the great towns of England. The latter species has now become exceedingly rare. The species of the genus *Mus* are distinguished by the great rapidity with which they increase their number.

Musa. [BANANA.]

Musaceæ (Musa, one of the genera). A small but important natural order of Endogenous plants belonging to the Amomal alliance, and related to the orders yielding ginger, arrow-root, &c.; but differing in having several stamens instead of one only. The Plantain (*Musa sapientum*), the most valuable product of the vegetable kingdom in hot countries, from the abundance of nutritious food yielded by its fruit, and from the application of its leaves in thatching, and of thread obtained from its petioles in the manufacture of the finest muslins, is the representative of the order. Another species is the *Musa paradisiaca*, or Banana; and the singular plants called *Strelitzias*, with their orange and blue flowers, are also members of the order of *Musaceæ*.

Musca (Lat. *a fly*). A Linnæan genus of Dipterous insects, now expanded into a family (*Muscidæ*) of the fifth tribe (*Athericera*) of the order *Diptera* in Latreille's system. It is distinguished by a proboscis always very apparent, membranous, and bilabiate, generally bearing two palpi, and capable of being entirely withdrawn into the oral cavity; and a sucker of two pieces. The antennæ always terminate in a plate with lateral setæ. The *Muscidæ* are divided into the sub-families *Creophilæ*, which includes the meat-fly (*Musca vomitoria*) and the common house-fly (*Musca domestica*); the *Anthomyzæ*, the *Hydromyzæ*, the *Scatomyzæ*, the *Dolichocera*, the *Leptopoditæ*, the *Capromyzæ*, the *Gymnomyzæ*, and the *Hypocera*.

Muscadine or **Muscatel.** A rich sweet wine made of Muscadine grapes in the South of France. These grapes are also dried on the vine, for fine table raisins.

Muschelkalk. The name given to the shelly limestone occupying the middle of the Triassic series of rocks on the continent of Europe. It is absent in England, and for this reason the upper and lower divisions of the new red sandstone run together, and are almost inseparable. The muschelkalk contains a good number of

characteristic fossils. It is generally compact, and of a pale ashy grey colour, but is sometimes bituminous, emitting a fetid odour when struck by the hammer.

Though not found in England, it is remarkably persistent in most parts of Western Europe, and almost always in its typical form. Among the fossils are some reptilian remains; and a peculiar Ammonite (*Ceratite*), intermediate between those of the carboniferous limestone and the secondary rocks, is almost if not absolutely characteristic of it.

Musci. [Mosses.]

Muscicapa (Lat. musca, *a fly*; capio, *I take*). A genus of Dentirostral Passerine birds, characterised by a depressed beak, furnished with hairs at its base, and with the point more or less hooked and emarginate. The genus is now split into various subgenera; as *Tyrannus*, *Gymnocephalus*, *Muscipeta*, and *Muscicapa* proper, &c., included in the family name of *Muscicapidæ*. Their general habits are cruel and predatory, like those of the shrikes; and, according to their size and strength, they live on small birds or insects. The smallest and weakest of the *Muscicapidæ* gradually approach the form of the wagtails.

Muscidæ. The family of Dipterous insects of which the fly (*Musca*) is the type.

Musciformes (Lat. musca, *a fly*; forma, *form*). The name of a tribe of *Tipulidæ*, or crane-flies, comprehending those which have a stout body and short legs, resembling the common flies.

Muscle (Lat. musculus, Gr. μῦς). Fleshy fibres susceptible of contractions and relaxations. Some of the muscles are obedient to the will, and therefore called *voluntary*; others, such as the heart, are independent of the will, or *involuntary*; and others, as the diaphragm and muscles of respiration, generally have a *mixed* action, being to a certain extent only dependent upon the will. Muscles are aggregates of minute muscular fibres, which appear to be composed of small globules; but we are, in fact, ignorant of the ultimate structure of the muscles, and of the causes on which their wonderful powers depend. They are enveloped in and penetrated by cellular membrane, and abundantly supplied by nerves, blood-vessels, and lymphatics.

When muscular flesh or fibre is carefully dried, it loses about 75 per cent. of water, so that a pound of what is usually called raw lean meat includes only about four ounces of what may properly be termed nutritive matter. When lean beef or other flesh is very finely minced, and digested in small but repeated portions of cold water, and well expressed, the principal soluble matters of the muscular tissue are squeezed out of it, and may be thus obtained in concentrated solution, the fibrine, fat, albuminous tissues, and some other insoluble bodies remaining in the residue. The juice thus obtained has an acid reaction; it contains phosphoric, inosic, lactic, butyric, and perhaps some other acids, tinged by the colouring principle of the blood; albumen and the salts of the blood are also found in it, together with kreatine and inosine; the latter, which has also been called *muscle-sugar* ($=C_{12}H_{12}O_{12}+4HO$), being a peculiar crystallisable sweet substance, not susceptible of vinous fermentation, and said to be chiefly confined to the involuntary muscles, more especially to the heart. (It is also said to be occasionally present in the urine, and to be identical with *phaseolomannite* or the sugar of the kidney-bean, *Phaseolus vulgaris*.) When the juice of flesh, obtained as just stated, is heated, it becomes turbid, and deposits albumen tinged by colouring matter, the coagulum amounting to about 3 per cent. of the fresh muscle. Fibrine, gelatine, albumen, fat, and other constituents of the muscle forming its fibre, nerves, vessels, &c., are the principal substances which remain after the exhaustion by cold water, and are of course highly important in reference to their value as elements of nutrition.

All the muscles are under the immediate influence of the brain and nerves; and consequently when this influence is abstracted, as by the division of the nervous trunks by which they are supplied, the powers and functions of the muscles, whether voluntary or involuntary, are in the first instance disturbed, and afterwards cease altogether. Electricity is capable to a certain extent of recalling the action of the muscles, provided it be applied before rigidity ensues; hence the supposed identity of that power of matter and certain properties of the nerves. The arrangement of the fibres of muscles is infinitely various, and adapted to the particular purposes which each has to fulfil. In the voluntary muscles the fibres are generally parallel, or nearly so; but in the involuntary muscles they are more or less interwoven and interlaced. When muscles contract, they become shorter, harder, and thicker, and their bundles of fibres are thrown into undulated lines, with a tremulous or vibratory motion, most rapid where the contraction is most powerful, and producing a distinct sound, which may be most easily heard when the tip of the finger is put into the ear; it occasions a noise like that of carriages rumbling over a distant pavement. (Wollaston, *Philosophical Transactions*, 1809.) The number of these vibrations amounts to between twenty or thirty in a second: these muscular sounds are importantly concerned in the diagnosis of certain diseases through the medium of the stethoscope.

Muscle Band. In coal-mines, the black shale containing embedded muscle shells.

Muscovado. The name given to unrefined or moist sugar.

Muscovy Glass. A synonym of Mica, from its having been formerly used in Russia as a substitute for window-glass.

Muses (Gr. Μοῦσαι, Lat. Musæ). In Mythology, the goddesses of music, poetry, art, and science. The worship of the nine Muses was a later developement. Pausanias states

that originally three were worshipped on Helicon, *Meletê*, *Mnêmê*, and *Aoidê*, or Reflection, Memory, and Song (ix. 291). Hesiod (*Theog.* 775 &c.) gives the names of nine, and calls them daughters of Zeus and Mnemosyne (or Memory), holding them to be the sources of eloquence, music, and wealth. [PIERIDES.]

Musette. A name sometimes given by the continental nations to the bagpipe. The itinerant performers on the musette, who were formerly very numerous in many European countries, were called *musars.*

Museum (Gr. μουσεῖον, from μοῦσα, *a muse*). A collection of curious objects in nature and art; but, in most instances, the former. The name denotes a temple or place sacred to the Muses; and is said to have been first given by Ptolemy Philadelphus to that part of the royal palace at Alexandria in which he placed the famous library. In England, the museum at Oxford is the most ancient institution bearing the name. It was founded in 1679, and enriched, in the first instance, chiefly by the contributions of Elias Ashmole; but want of room and of funds has prevented it from affording an adequate exhibition of the various classes of objects for which it was originally destined, and which modern discoveries have so greatly augmented. The foundation of the British Museum, in London, was laid by Sir Richard Cotton's presentation of his collection of manuscripts. Since that period the library has been increased by the addition of the Harleian, Lansdowne, Egerton, and several other collections of MSS.; by extensive purchases out of funds afforded by government; by the deposit of copies of newly published works, according to the legal right conferred on this institution; and by the donations of George III. and George IV., the latter of whom presented to it his father's library. In sculpture, the British Museum possesses among other things the collection of marbles brought by Lord Elgin from Greece, that called the Townley marbles, an assemblage of Egyptian, and the Layard or Nineveh works of art, together with recent acquisitions from Lycia and other parts of Asia Minor. It contains also the Hamilton vases, the famous Berberini or Portland vase, and the collection of Etruscan art formed by Sir W. Temple. In several departments of natural history, especially in mineralogy, it is extremely rich. It was founded by Sir Hans Sloane in 1733, and filled the mansion known by the name of Montague House, until the present buildings were erected. The most celebrated museum in Italy is the Vatican, at Rome; next to it that of Florence, and the Museo Borbonico, at Naples. In France, as well as in Italy, galleries of pictures are considered as within the meaning of the general term *musée*, and the museum of the Louvre is chiefly remarkable for its contents of this description.

Mushroom (Fr. mousseron). The *Agaricus campestris*, or eatable agaric—a species common in pastures, and well known for its culinary excellence. The term is sometimes applied indiscriminately to all firm fleshy species of the genus *Agaricus*, whether eatable or not.

There is no doubt that *Agaricus campestris* is preferable to any of the allied species, though it must not be regarded as the only one that is wholesome. Indeed, it is rejected from many Italian markets, where species of more suspicious character are allowed to pass muster. A large variety of the mushroom called the Ox Mushroom measures sometimes fifteen inches across, with a proportionately stout stem. The pileus is rough with scales; the gills are quite free, leaving a groove round the top of the stem; the smell is powerful, but agreeable. It grows in enormous rings many yards in diameter, and is wholesome, and of fine flavour.

It is impossible to give any general rule for avoiding poisonous mushrooms; but no one should eat Fungi which have a revolting smell, or leave a hot sensation in the mouth and throat. They should moreover always be eaten in moderation, and well masticated. In case of accident, an emetic should be taken immediately, and medical advice called in; for the symptoms of poisoning from fungi are too grave to be trifled with by domestic medicine.

Mushtáhids. In Persia, high priests who represent the vicar of the Imam; they are usually three or four in number, and exercise enormous influence in the administration of the written law.

Music (Gr. μουσική, sc. τέχνη). Literally, any art over which the Muses presided. The primitive Athenian education consisted of two branches, *music* for the mind, *gymnastics* for the body, but the former term had a much wider signification than that which it now bears. It comprehended not merely the use of the lyre or the taking part in a chorus, but also elocution; and as knowledge advanced, the term was so extended as to include all the learning and accomplishments of the age. In the more modern and restricted sense, music is the art of combining sounds in a manner agreeable to the ear.

Hebrew Music.—Notwithstanding the labours of the early fathers of the church, and of many other learned men, there are few materials, even in the Old Testament Scriptures, for a satisfactory account of the music of the Jewish people, whose restricted intercourse with other nations prevents our receiving any illustration of it from contemporary writers. From several passages in these Scriptures music appears to have been united with prophecy. Samuel (1 Sam. x. 5) says to Saul, 'Thou shalt meet a company of prophets coming down from the high place, with a psaltery, and a tabret, and a pipe, and a harp before them.' These prophets were doubtless poets or psalmodists, improvisatori of verses which they sang to the accompaniment of an instrument; and many of the fathers have supposed that the Jews had a college or school of prophets, which was also a school of music, for they almost universally accompanied themselves, or were

accompanied by others, with musical instruments. During the reign of David music was much esteemed. He appointed a great corps of musicians for the celebration of the religious ceremonies; and his patronage necessarily extended its influence. But for some time before the destruction of the Temple and the first Babylonish captivity, music and the sacred rites had met with interruption, both on account of war and by their intercourse with foreign nations. The Babylonish captivity was a mortal blow to the endeavours they had made to recover their music. The subsequent inroads of Egyptians, Persians, and Romans successively left the unfortunate Jews no leisure to cultivate the arts; and it appears probable that their music, which scarcely deserved the name till the reign of David, depended for effect, even at its best epoch, more upon the number of performers than upon any refined knowledge of the art.

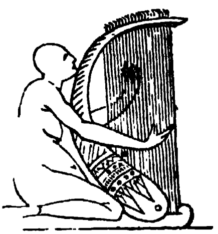
Among the modern Jews, instrumental as well as vocal music was excluded from the synagogue from the time of the destruction of Jerusalem. The singing allowed at the present day is a modern innovation: for, according to a passage of their prophets, the Jews consider it contrary to their law, or at least improper, to sing or rejoice until the coming of the Messiah. The German Jews alone at the present day have a regular musical establishment in their synagogues. They sing in parts, and have preserved traditional melodies, which are considered very ancient. At Prague an organ is used to accompany the singing

Egyptian Music. — The opinion of the ancients was pretty general that Pythagoras was indebted to the lessons of the Egyptian priests for nearly all the science he possessed, and especially that of music. Though Diodorus Siculus assures us that the Egyptians were not allowed to cultivate music, and that they considered it useless and even injurious to society, and the cause of effeminacy; yet Plato, who had visited Egypt, observes, in one of his Dialogues, that none but excellent music was allowed where the youth were assembled. Strabo tells us that the youth were instructed at the earliest age in music, that the songs were fixed by law, and that the sort of music used was established by the government exclusive of every other sort. The Greeks even attributed the invention of some of their musical instruments to the Egyptians; such as the triangular lyre, the single flute, the drum, and the sistrum (Gr. *σεῖστρον, a rattle*).

Like all other professions in Egypt, that of music was hereditary. Herodotus tells us that the inhabitants of Lacedæmon, who were Dorians, resembled the Egyptians in this, that their musicians were all of the same family; and that their priests, like those of Egypt, were taught medicine, and the art of playing upon stringed instruments, when they were initiated into the mysteries of religion. The same author mentions that in the processions of Osiris the Egyptians carried statues of the god, singing his praises, and were preceded by a flute. A singular proof of the antiquity of this art exists at Rome, on the Guglia Rotta, in the shape of a large obelisk brought from Egypt by Augustus, and thrown down and broken at the sacking of the city, in 1527, by the constable of Bourbon. It exhibits, among other hieroglyphics, the representation of an instrument, as here given, very like the colacsione (a species of guitar) still in use in Naples. From the pegs it is evident that two strings were employed; and the length of the finger-board, if the strings were tuned at a great interval from each other, would afford a very considerable scale of notes. This instrument alone proves to what extent music was cultivated in Egypt, and that its inhabitants were acquainted with the method of repeating the scale. Thoth, or the ancient Hermes Trismegistus, to whom is ascribed the invention of writing, astronomy, religious rites and ceremonies, has the credit also of having invented the lyre, with three strings. The following, according to one form of the myth, was the origin of the invention: The Nile, after its inundation on one occasion, left on retiring a quantity of dead animals, and among the rest a tortoise. The flesh soon perished and dried up, from the heat of the sun; nothing but the shell and the cartilages was left, and from their contraction they had become sonorous. Hermes, strolling on the banks of the river, struck his foot against this tortoise-shell, and was agreeably surprised by the sound it produced; and this furnished him with the first idea of a lyre. He gave his instrument the general form of the shell, and strung it with the dried tendons of animals, resembling the gut-strings of the present day. This is, however, only a Euhemeristic or rationalised version of the myth, which is given in a more genuine form in the Homeric Hymn to Hermes, and in Apollodorus iii. 10. 2.

The single flute, called *photinx*, seems to have greater claims to antiquity than the lyre itself. Apuleius, describing the mysteries of Isis, tells us the form of this instrument, as well as the manner in which it was held; and all the representations of it show that it resembled the bullock's horn. Indeed, there can be no doubt that, in the remotest period, the horns themselves were used for the purpose. But it is certain that the Egyptians had instruments much more susceptible of inflection than those of which we have been speaking; for on the ceilings and walls of the chambers of the tomb of Osymandyas, at Thebes, described very circumstantially by Diodorus, there are, among other decorations, several representations of musical instruments; one of which, from Denon, is given on the next page, for the purpose of showing the reader that the harp of the present day is in general form not very dissimilar to the instrument then in Egyptian use, and that perform-

ance upon it must have required considerable skill. Other representations of harps occur;



one has been given by Dr. Burney. A harp figured at Ptolemais, a city built by Ptolemy Philadelphus, exhibits fifteen strings, or two complete octaves: this, however, is more triangular in shape, and much more like the modern harp. The instruments in Abyssinia were found by Bruce to have a close resemblance to those of Egypt.

The arts which flourished in this nation at so early a period would doubtless have continued to do so under their own kings; but after the subjugation of the nation by Cambyses, B.C. 525, a period of great depression followed. The Ptolemies, indeed, encouraged the arts; but under their reigns they were cultivated chiefly by Greeks. At a feast of Bacchus, given by Ptolemy Philadelphus, Athenæus says that the choir was composed of six hundred musicians, and of that number one-half were performers on the cithara. According to the same author, under the seventh Ptolemy, Egypt abounded with musicians; and at this period the practice of music was so common in the country, that there was not a peasant or labourer near Alexandria unable to play on the lyre and flute. The father of Cleopatra, who was the last of the Ptolemies, from his skill on the flute took the title of Auletes (flute-player), and established musical competitions in his palace, himself disputing the prize with the first musicians of the day. Such was the flourishing state of the art in Egypt up to the time of Cleopatra's misfortunes. Among the modern Egyptians no remains or traces of the ancient art are now to be found. Still they are passionately fond of music; and there are, according to Savary, to be found among them both male and female musicians who sing and accompany themselves. This author describes them as most successful in their plaintive music; to which, he says, even the Turks themselves, the enemies of art, will pass whole nights in listening.

Grecian Music.—According to the logographers, who modified the Greek myths to suit their own purposes, there came into Greece with Cadmus, the son of Agenor, a class of men well versed in the arts and sciences, and called Curetes. These established themselves in Phrygia, where they were called Corybantes; and in Crete, where they received the name of Dactyli: they spread also into Rhodes, Samothracia, and other places. In these places writing and music, we are told, were the arts principally taught by them. The legend goes on to say that Cadmus, in Samothracia, took to wife Harmonia (sister of Jasius and Dardanus), who was so skilled in music that the Greeks gave her name to the art. Diodorus, in describing the marriage feast of the parties, makes the gods themselves guests. Hermes came with his lyre, Apollo brought a similar instrument, Athena assisted with a flute, and the Muses also brought their flutes; Electra, the mother of the bride, celebrated the mysteries of Cybele with dancing, tambourines, and cymbals. This story was probably founded on ceremonies which the priests, at certain festivals, performed in honour of Harmonia and Cadmus. It is unnecessary, however, to notice here the mythical tales which involve reference to the art of music, as not a particle of genuine history can be extracted from them.

The instruments mentioned in the *Iliad* and *Odyssey* are the lyre, the flute, the syrinx, or Pan's pipes. The lyre in the Homeric poems is called φόρμιγξ, κιθάρα, and χέλυς; Aristophanes being the first Greek poet who calls it λύρα. In the Homeric poems music and poetry are inseparable: ἀοιδός, *a singer*, being the word used to express a poet. In the eighth book of the *Odyssey*, Demodocus is described in his character of poet and singer as the glory of the human race. The poets and musicians of Greece appear to have much resembled the Celtic bards. They wandered about, singing their works in great cities, and usually found admission to the palaces of princes, where they were treated as though endued with inspiration. Burney remarks that religion only can impart permanence to any system of music; and he conjectures that the airs sung in the temples in the time of Plutarch were then of the same relative antiquity as to us is the plain chant of the hymns of the Catholic Church. Plato, Porphyry, Athenæus, and the scholiast of Pindar, speak highly of the talents of Thaletas of Crete, who is said to have founded the second of the musical schools which flourished at Sparta. If we are to credit Plutarch, Archilochus contributed more than any other to the advancement of poetry and music. Herodotus, always ready to ascribe historical sequence to mythical or semi-mythical times, makes him the contemporary of Candaules, and of Gyges, king of Lydia, 724 years before Christ; but modern chronologists place him much later. He was a native of Paros.

Without entering into particulars, it is sufficient to mention that at this period melody was strictly determined by the measure of the verse. A different set of feet in a verse necessarily required new airs in the music. Hexameter was the most ancient species of measure, and so continued till the introduction of lyric poetry. If Archilochus was the inventor of music different to that which suited the hexameter verse, he was indeed the inventor of lyric poetry, which after his time became a species of versification totally distinct from that of the heroic. Archilochus is supposed to have been one of the first conquerors at the Pythian games. Tyrtæus, who was a soldier as well as a musician, was celebrated for his military

songs or airs. The scholiast of Horace makes the Lacedæmonians indebted to him, during the Messenian war, for a victory in a battle, in which he led them on to the sound of the military flute, and states that for this good service they rewarded him with the rights of citizenship. The authors who have written on the progressive state of Greek music unanimously celebrate the talents of Terpander; but neither the exact time of his appearance, nor the place of his birth, can be ascertained. Many have given him the credit of having added the three strings to the lyre: it is said, however, that he was the first who used the seven-stringed lyre among the Lacedæmonians, by which he gave great offence to the people. The Spartans disliked innovation, and Plutarch relates that the Ephori fined him for his invention. The Arundelian marbles state that he obtained the first prize in music at the games instituted at Sparta to avert the anger of Apollo for the murder of one of his priests by the Dorians. Plutarch says that no other proof of his skill could be wanting, seeing that his name appears four times on the register of the Pythian games, where he carried off successively four of the prizes. At the Grecian games music formed a principal part of the ceremony: the combats were to the sound of music. In the dramatic representations, the declamation was accompanied by an orchestra, and there were moreover particular prizes allotted to the professors of the art. At first music had but little share in the Olympic games, but at a later period prizes were given to successful competitors in this art. It is well authenticated that, at a comparatively late period, Nero appeared at them, and of course carried off the prize. The Pythian games, founded in remembrance of Apollo's mythical victory over the serpent Python, were at first confined to poetical and lyrical contests; but in these music was afterwards admitted to a share of the prizes; and, in the year 559 before Christ, a crown was decreed to the best performer on the lyre, or, rather, on an instrument with strings. The prize was nothing more than a laurel crown, in memory of the love of Apollo for Daphne; though afterwards the apple, a fruit consecrated to Apollo, was added. At these games a peculiar musical composition was performed, of considerable length, in allusion to the contest of the god with the serpent: it was composed by Sacadas, and sung for the first time by him at Delphi. Among the musicians and poets who distinguished themselves at these games were Alcman of Sardes; Alcæus of Mitylene, the contemporary of Sappho (to the latter of whom Aristoxenus and Plutarch attribute the invention of the Mixolydian mode, of which Plato, the advocate of simplicity in music, much complains); Mimnermus, famous for his performances on the flute, in the sixth century before the Christian era; Simonides, born at Ceos, 538 B.C., the master of Pindar, who was born at Thebes, in Bœotia, about 520 years before our era. At the Nemean games, which took their name from Nemea, a village in Arcadia, the contests were somewhat similar to those at the Olympic games, and it is known that those in music formed a portion. It was at these games that the musician Pyladès, of Megalopolis, sang, accompanied by the lyre, an air composed by Timotheus, in which the words were so suited to the circumstances of the battle of Mantinea, that the audience immediately turned their eyes to Philopœmen, who was present, and interrupted the singer by shouts and acclamations of applause. Timotheus, born at Miletus, 446 B.C., was one of the most celebrated poets and musicians of antiquity. Pausanias tells us that to the seven strings of the lyre he added four more; though Suidas says that he added but two, the tenth and the eleventh: for which innovation he was banished from Sparta, and ordered to cut off the additional strings, that he might not corrupt the ears of the youth with too great a variety of notes. This Timotheus, who died two years before the birth of Alexander, must not be confounded with the celebrated flute-player who was so great a favourite with that prince, and whose tones animated him to arms. The Isthmian did not differ from the games already described: they received their name from being celebrated on the isthmus of Corinth. Other games existed in different cities, as, for instance, the Panathenaic at Athens. Music was cultivated at all, and held in much esteem.

At Athens, in the time of Pericles, music was considered so necessary a part of education, that not to understand it nor play any instrument was considered a disgrace. Pericles was especially zealous in his patronage of music. Besides regulating the form and increasing the number of musical competitions at the Panathenaic festivals, he built an edifice called the Odeum, for the express purpose of rehearsals previous to performance in the theatre. It was during his era that Antigonides and Dorion, the two most eminent flute-players, flourished. So great appears to have been the passion for flute-playing, that as much as three talents (upwards of 600*l.*) were given for a single flute. Women also were performers on the flute. Of these the most renowned was Lamia, to whom, for the benefits she had prevailed on Demetrius to confer upon the city, the Athenians dedicated a temple, under the name of Aphroditê Lamia. It seems that execution on this instrument was carried to a great extent; for Aristotle cries out against the difficult passages that used to be practised, and even against music generally. The people, however, who, as a mass, are never disposed to give up the pleasures of sense for those of the mind, continued to encourage these novelties and their authors; and, from being the handmaid, music became the mistress of poetry. The justice of the complaints of Plato and Aristotle on this point is confirmed by Aristoxenus himself, well skilled in the art; and Plutarch frequently

laments that the theatre had ruined music. After the complete subjugation of the Greeks, music, like the rest of the arts, fell into decay. They continued, indeed, to cultivate music under the Roman emperors, and under their own: even afterwards, under the Turks, it was one of their amusements; but so barbarous is it in the present day, that it is difficult to conceive that the same nation ever possessed a music which drew down the plaudits of thousands. To form any idea of the ancient Greek music is now past all hope: materials upon which we could judge have long since passed away; but we will add, in conclusion to this section, the opinion of M. Ginguené on the subject. 'We see in the poetical works of the Greeks the variety and liveliness of their passions, and these same passions could not be expressed in music without an equal variety of air and modulation. I do not mean by that to say that Greek music was entirely similar to our own: to decide that point it would be necessary to hear and compare the one with the other. I maintain only that Greek music was full of harmony; that it admitted that variety of modulation which alone can give pleasure to cultivated minds; and that to suppose that the Greeks were pleased with a music that comprehended but four notes is one of the greatest follies that can be imagined.'

Roman Music.—Strabo and Livy affirm that the public music of the Romans, as used at sacrifices, was learnt from the Etruscans. Servius Tullius, in his alleged division of the people into classes or centuries, is said to have directed that two entire centuries should consist of trumpeters, horn-players, and those who sounded the charge. One hundred and fifty years afterwards, the marshal at funerals was, by the laws of the twelve tables, directed to provide six flute-players. Among the Romans, as was also the case with the Greeks [see above], music and the drama were inseparable. In the end these exhibitions became offensive; but the further notice of these is unnecessary in this place. Music, however, was for a long period confined to sacred uses; and it was only after the defeat of Antiochus the Great that the Asiatic custom was introduced of having female musicians—*psaltriæ*—to play at festivals and private banquets. The Etruscan music was cultivated with success; for all the instruments of the Greeks, which are known to us from their bas-reliefs, are to be found in paintings on Etruscan vases: so that it may be safely assumed that the Romans were accustomed to the best music that the age afforded. Under Augustus, who was not a great patron of the art, music was not much esteemed. Tiberius banished musicians from the city, which under him became as sad as in the days of Augustus it had been lively. Caligula, however, recalled them. Claudius, though he patronised gladiatorial fights in preference to music, still encouraged the art; but under Nero it shone in all its ancient splendour. Such was this emperor's delight in it, that he passed a great portion of his time in taking lessons of Torpus, the most skilful harpist and lyrist of his day. Nero's successors were patrons of the public games, and of dramatic and musical exhibitions throughout the empire. Hadrian had always been attached to the arts of Greece. He instituted new games, which his successor Antoninus continued. Commodus, whose disposition was similar to Nero's in cruelty, resembled him also in an intense passion for the stage, on which he delighted to appear as a singer and dancer. The fall of the empire necessarily induced the fall of the arts, and music, of course, among the rest: in short, it disappeared with them—with them to spring into new life and surpass all its former glory, after centuries had passed away, and all art seemed to have been lost for ever.

Italian Music.—Italy has been to the rest of Europe in modern times what ancient Greece was to Rome. Though we cannot so well trace the art of music in its early restoration as we can the arts of design, we know that to the religion and church which brought them forward we are indebted for the foundation of all that is good in the musical art. The plain chant of the Catholic Church is said to owe its origin to St. Ambrose, archbishop of Milan, in the fourth century. He, it is generally understood, brought it into form and based it upon rules, and two centuries afterwards it was considerably amplified and improved by Gregory the Great, who introduced the kind of music known as Gregorian, and which is still used in the service of the Roman Catholic Church in all countries. The music of Italy, aided by a language which Metastasio called *musica stessa*, notwithstanding the revolutions which it at first underwent, at length became the guide for the rest of Europe. Even out of the church, as early as the thirteenth century, music was cultivated; for Prince Conrad, in 1268, went out against Charles I. of Sicily with a female choir accompanied by cymbals, drums, flutes, violins, and other instruments; and it is known that all the courts of Italy were filled with musicians, for the amusement of their sovereigns. At Florence is still in existence a manuscript collection of sacred songs, entitled *Laudi Spirituali*, in honour of God, the Virgin, saints and martyrs, which as early as 1310 used to be sung by a society called the *Laudisti*. A society of this sort existed when Dr. Burney was at Florence in 1770; and he states that he often heard them singing about the streets in three parts, accompanied by a portable organ. When Petrarch was crowned with laurel at Rome, in 1341, music was introduced to grace the ceremony; and from the account of that ceremony, printed at Padua in 1549, it appears that it consisted of instrumental as well as vocal music. It appears that, in 1022, Guido, a Benedictine monk of Arezzo, was the first who imagined the scheme of designating by points, distributed upon lines and spaces, the different sounds of the octave. The French, however,

claimed the credit of this invention for Hubald and Odo a century before the time of Guido.

Guido gave to the notes the names *ut*, *re*, *mi*, *fa*, *sol*, *la*, taking them, it is said, from the first syllables of words in the first stanza of the hymn of St. John the Baptist, in which they are certainly found:—

> *Ut* queant laxis *re*sonare fibris,
> *Mi*ra gestorum *fa*muli tuorum,
> *Sol*ve polluti *la*bii reatum.

The syllable *si* was afterwards added by a musician called Le Maire. From a manuscript in the Vatican dedicated to Charles, king of Sicily, above mentioned, it appears that Marchetto of Padua had improved the art; for the MS. proves that he was acquainted with dissonances and chromatic counterpoint. That the science was making vast strides from the old plain chant is clear from the bull of Pope John XXII. in the early part of the fourteenth century, wherein complaint is made of what he was pleased to call the abuse of descant, by which the principles of the antiphonal and gradual had fallen into such contempt that the singers could no longer recognise the foundations upon which melodies were established, and that it exceeded the bounds which the ecclesiastical tones prescribed. Without particularising the steps by which it continued to advance, the *Ars contrapuncti* of John de Muris, in 1330, laid down laws of harmony, some of which are observed in composition at the present hour. He says that, in the scale of the octave, there are six species of consonances—three perfect and three imperfect. Of the first sort are the unison, the octave, and the fifth; of the second sort, the two thirds, major and minor, and the sixth major. It is curious that he did not place the minor sixth among the number of consonances, since it is but an inversion of the major third, which he admits to be a consonance. Prosdoscimus, in 1412, speaks of the fourth, of which no mention is made by De Muris, and treats it as a dissonance; though, he says, it is less so than the second and the seventh, and that it may be placed in a middle class, between consonances and dissonances. Advanced, however, as the science became at this period, it was not until the middle of the fifteenth century that the laws of harmony were fixed on the foundation that still bears the superstructure of the refined combinations of even modern music. The first treatise on music was printed in Italy towards the end of the fifteenth century, by John Tinctor; but that published a few years afterwards, by Franchino Gafforio (printed in 1496 at Milan), excelled its precursor. The claim of the Italians to the invention of counterpoint has been disputed in favour of the Flemings, and also of the English. There is no doubt that the former contributed much to its advancement and perfection; but the works extant, if we are to judge from them, satisfy us that the claim cannot be maintained. In the compositions of this period there is a want of melody which all their display of science and curious combinations could not atone for; but in the sixteenth century melody and counterpoint were united by the splendid genius of Palestrina, and some of his contemporaries and disciples; and the art was enriched by the treatises of Peter Aaron, Zarlino, Artusi of Bologna, the Venetian Zacconi, and many others, which spread throughout Europe, and left scarcely more to be desired on the first principles of music as a science. Palestrina, the principal cause of this revolution, began his career by a diligent study of the masters who had preceded him, making himself familiar with their difficulties and with their styles. Applying himself to the simplification and purification of harmony, and to the discovery of more flowing and natural melodies, he nevertheless paid a degree of homage to the preceding school, whose pedantry and obscurity he knew how to correct.

The Gothic style of composing masses and motetts on a canto fermo, which he practised in his early compositions, he entirely abandoned after 1570 His style, upon which he was continually refining, became at last the model of the age; and after his time, for a considerable period, the best ecclesiastical compositions were honoured by being called *alla Palestrina*. Nanino, his fellow student and intimate friend, Cifra, his disciple Luca Marenzio, and many other masters of the Roman school, gloried to tread in his steps; whilst Zarlino at Venice, Costanzo Porta at Padua, Orazio Vecchi and Monteverde at Mantua, Bottrigari and Orturi at Bologna, endeavoured, and with considerable success, to build their counterpoint with the clearness, purity, and elegance of the great master of modern music. Among these Monteverde is particularly to be noticed, for his passing beyond the master whom he followed. He was the first who used double discords, such as the ninth and fourth, the seventh and ninth, and the seventh and second; as also the unprepared false fifth and seventh. This at the time created great disputes in the republic of music. Monteverde, in prefaces and letters, defended his practice; but his best defence was to be found in the progress made by him. The licenses he took, far from being offensive to the ear, were soon adopted by others who had abused them. The passion for fugues, canons, and other difficult compositions of that nature, requiring the highest degree of science, continued in the seventeenth century, which produced many learned musicians. One of the most extraordinary of these was Francesco Soriano, who published 110 canons upon the hymn *Ave Maris Stella*, for four, five, six, seven, and eight voices; but Pietro Valentini went far beyond him, and has left, it is to be apprehended, all future canonists in a hopeless condition. He wrote one to the words *Illos tuos misericordes oculos*, &c. resolved in more than two hundred different ways, for two, three, four, and five voices; another for ninety-six voices; a third for twenty voices only, but

with four different subjects going at the same time. Other masters employed themselves in a similar manner. Of the Roman school, also, Luca Marenzio merits special mention here: though great in church music, he is best known and admired for his exquisite madrigals, which still continue to be performed in this country. Marenzio died at Rome, in 1599. At the head of the Venetian school, the Italians themselves place Adrian Willaert, a Fleming. To him Zarlino attributes the invention of composition for more than one choir. He was maestro di capella of the church of St. Mark at Venice. His works are voluminous: his disciples were Cipriano Rore, Zarlino, and Costanzo Porta. The Neapolitan school, one of the most celebrated in Italy, was established in the fifteenth century, under the reign of Ferdinand of Arragon, a great patron of all the arts. It was at Naples that Gafforio and Tinctor, whom we have before mentioned, Guarnerio, and many others, distinguished themselves. Church and madrigal music there flourished. In the latter branch, Carlo Gesualdo, prince of Venosa, showed in an eminent degree the powers of that style of writing. The Lombard school registers the names of Costanzo Porta, its head; Gastoldi, Giuseppe Biffi, and Paola Cima, of Milan; Pietro Ponzio of Parma; Orazio Vecchi of Modena; and Claudio Monteverde. The most celebrated disciples of Porta were Balbi and Piccioli. Orazio Vecchi was among the first composers of dramatic music, and for a considerable time maestro di capella at Mantua. The Bolognese school comprises few writers in the sixteenth century, though in the century following its professors equalled those of the first rank throughout Europe. Andrea Rota may be considered the head of it. Florence in music seems to take no distinguished place: we know only of Alessandro Striggio and Francesco Cortuccia as enjoying much reputation.

Dramatic music appeared in Italy in the fifteenth century, a musical tragedy having been acted at Rome in 1480; but the real epoch of the music of the drama can scarcely be dated before 1597, and its first appearance was at Florence. Ottavio Rinuccini is recorded as the poet, and Peri as the musician, both Florentines, and the name of the piece *Daphne.* This priority is, however, disputed in favour of Vincenzo Galileo, the father of the celebrated astronomer, who, desirous of recovering the musical declamation of the Greeks, imagined a recitative applied to the episode of Ugolino in Dante. Up to the middle of the seventeenth century the drama was principally recitative, when, in 1649, Cavalli began to introduce more airs than had hitherto been used, a practice further extended in the *Doria* of Cesti, composed in 1663; after which, for some time, it degenerated so much into *spectacle*, that, in the works represented about the end of the seventeenth century, neither poet, composer, nor singers are recorded, but the machinist and decorator only. Among the composers were, however, men of great knowledge and genius, such as Gasparini, Perti, Colonna, Lotti, and Alessandro Scarlatti, who is said to have been the inventor of the obligato recitative. Great improvements were introduced in the beginning of the eighteenth century by the pupils of Scarlatti; viz. Leo, Vinci, Sarro, Hasse, Porpora, Feo, Abos, and particularly Pergolese. About the middle of the century appeared Jomelli, Piccini, Sacchini, Guglielmi, Traetta, Anfossi, and others, whose names are not less celebrated than their predecessors, and the century closes with Paisiello and Cimarosa. It remained, however, for a Bohemian, Glück, to accomplish the revolution which has brought the opera to its present state in Europe.

Europe is as much indebted to Italy for the introduction of instrumental as for that of vocal music: the Italians have been the instructors in both. Violin music was cultivated by Corelli and Tartini, and their pupils, before other nations had thought of it; and the same may be said of the harpsichord, from Frescobaldi to Clementi. So, in concerted pieces, Boccherini introduced the quintett; and indeed, short of the symphony, which we owe to the Germans, their early superiority cannot be disputed. In our time a sensible decay is visible in Italian music; the art seems to have left its ancient seat to abide in Germany, where it has been cultivated with astonishing ardour and success.

German Music.—The Germans owe their music to the Italians. They received the Gregorian chant from Italy; and, though they may not have equalled their masters in vocal melody, they have greatly surpassed them in instrumental music. It is certain that, at the beginning of the seventeenth century, the music of Germany was greatly inferior to that of Italy; and it was not till the end of this century that the Germans began to evince high and successful talent for the art. We are not acquainted with any of the earlier music of the German church—similar in character, we mean, to that produced by the school of Palestrina in Italy; but in later times the writings for that church, by Graun, Haydn, and Mozart, have become highly popular. In the madrigal style we believe they exhibit no specimens, which is the more remarkable, from the circumstance of the German school having been considered by some to have been of as early an origin as the Flemish. The oratorios possess the greatest beauties: we need only name the *Passions Musik*, by Bach; the *Messiah* and *Israel in Egypt*, by Handel; the *Creation*, by Haydn; and *Elijah*, by Mendelssohn. Though not so old as that of Italy, the German theatre is nevertheless of early origin; but until Keyser appeared to compose for the theatre at Hamburg, about the end of the seventeenth century, it was without celebrity. During the whole of the last century, the German composers bred in the Neapolitan school carried their style into Germany, where it became the model of

the country. John Adolphus Hasse had the principal share in the transference of this style, which, improved by Graun, Neumann, Glück, and carried still further by Haydn and Mozart, has travelled back to Italy, to shine in Rossini and others, though Meyerbeer, a German, stands in the highest rank among modern opera writers. Glück, though by birth a German, belongs properly to France; for, strange to say, he was not properly appreciated by his own countrymen, though in later years they found out their error, and acknowledge it still by the rapture with which his works are now received. Germany derives its greatest reputation from the success with which it has cultivated instrumental music, particularly the grand symphony, in which the science and art of music put forth their highest powers. Haydn, Mozart, Beethoven, Mendelssohn, and Spohr are the greatest writers of this high style of composition, as well as of other allied forms of instrumental music, as the quartett and quintett, the concerto, &c. In harpsichord and pianoforte music, it may be safely said they have surpassed all other nations; for it would be difficult to find names in that respect of equal reputation with those of J. S. Bach, of Handel, Mozart, Düssek, Cramer, and a host of others, culminating in the giant Beethoven. The music of wind instruments seems to belong almost exclusively to Germany: their organists are excellent, and their orchestras well regulated. In musical literature they are superior to every other nation: witness the works of Fux, Matheson, Marpurg, Kirberger, E. Bach, Albrechtsberger, Forkel, Koch, and a host of others, most of them of the eighteenth century. In the present day, it is by no means surprising that the success of the Germans should be so extraordinary, seeing that there is no school for the education of youth in the country at which music is not taught and cultivated, even down to those where children receive gratuitous instruction.

Flemish Music.—The Flemish have been frequently confounded with French musicians; so that it is rather difficult to separate, at times, the one from the other. Louis Guicciardini (*Descrizione di tutti i Paesi Bassi*, published 1556) gives a list of all the musicians born in the Low Countries, and at that time dispersed in different parts of Europe, which robs the French catalogue of some of its most distinguished names. From the fifteenth century Flanders, from its commerce, wealth, and superfluous riches, was enabled to patronise the fine arts, especially in the times of Charles V. and Francis I. These monarchs, who lived less in their own capitals than elsewhere, seem to have carried the arts with them wherever they went; and when we recollect their frequent sojourns at Brussels, Antwerp, and other cities of Flanders, we are not surprised at the number of excellent musicians that Flanders produced. John Tinctor flourished about 1474: he was a native of Flanders, and maestro di capella to Ferdinand of Arragon, king of Sicily and Naples. He is the earliest theoretician whose name has reached us. Soon after, or contemporary with him, was John Okenheim, the first composer of music in parts. From the fragments which have been preserved by Glareanus, he appears to have been a learned writer, whose works seem more calculated to please the eye than the ear; and from the authors of the following century who notice him, we learn that he was the writer of a motett in thirty-six parts. Josquin des Prés, or, as the Italians call him, Josquino del Prato, was Okenheim's most celebrated scholar. The laws and difficulties of canon, fugue, augmentation, diminution, inversion, and other practices of church music, were by him observed and overcome in the most felicitous manner; and he has by some been dignified with the title of father of modern harmony, inasmuch as his era is nearly a century before that of Palestrina, Orlando di Lasso, &c. It is proper to state that Guicciardini claims Josquin as an Italian; and, at least, there can be no doubt that he was educated in Italy, inasmuch as he was a singer in the chapel of Sextus IV. His compositions were extremely numerous, and as often executed in the beginning of the sixteenth century as those of Handel were in England fifty or sixty years ago. His death took place at Brussels; and his monument is still to be seen in the church of St. Gudule. Hobrect, or Obrect, was a good composer of this period, and adds to his talent the honour of having been selected by Erasmus to instruct him in the principles of his art. We must pass shortly over the names of Pierre de la Rue, or Petrus Platensis, as he was sometimes called, Jean Mouton, Verdelot, Nicolas Gambert, maestro di capella of Charles V., Jacques de Wert, Pevernage, Lupi, Waelrent or Wraelrent, Verdonk, Arkadelt, and others, many of whom are still known to the musical antiquary by their madrigal compositions, though they were called only *songs for parts* in Flanders. Between 1544 and 1555 more than twenty collections of these *chansons* or madrigals were published at Antwerp and Louvain, by Tylman, Susaro, and Pierre Phalaise, who were themselves good composers; as were, in the same century, the publishers Rhau at Wittenberg, Gardano and Scotto at Venice, Ballard in France, and Tallis and Bird in England. After Clemens (non papa), an elegant and exquisite, though not voluminous writer, and Cypriano Rore, a pupil of Adrian Willaert, must be recorded the name of Orlando di Lasso, one of the most diligent and celebrated writers of the sixteenth century. He was born at Mons in 1520, and died at Munich in 1593. Living to a great age, the number of his works exceeds those even of Palestrina. Fifty collections of his different works are still extant, consisting of masses, motetts, passions, psalms, and songs or madrigals, printed in Italy, Germany, France, and the Low Countries. Such was his reputation, that the following verse was written for his epitaph:—

Hic ille Orlandus Lassum qui recreat orbem.

Ginguené, speaking of Cypriano Rore and Orlando di Lasso, says, 'These two Flemings, having passed the greater portion of their lives in the courts of princes, had acquired a lighter style, and a species of melody more appropriate to secular music, than that of Palestrina, who, residing at Rome, and writing principally for the church, exhibits in all his productions a gravity belonging to the species.' And again, 'They were two masters of harmony; and, the church excepted, they prepared the colours and set the palettes of musicians with many new tints of harmony and modulation, which were exceedingly serviceable to those who came after them.' These were the first masters who ventured upon chromatic passages, and upon accidental flats and sharps. From the epoch of these men, Flanders ceased to have a school of music especially belonging to itself.

French Music.—Hubald de St. Amand and Eudes de Cluni have been named by the French writers as having preceded Guido in the knowledge of the scale; but, without venturing to decide between the claimants, it may be safely said that France, as respects the art and science of music, was much advanced at a very early period, and that the country certainly boasted of many church musicians between the eighth and eleventh centuries; for besides the two already named, we have Remi, a monk of St. Germain d'Auxerre, Gerbert le Scholastique, and others whose knowledge is well authenticated. In the fourteenth century Philippe de Vitry, archbishop of Meaux, applied himself to music and poetry with considerable success. A manuscript preserved in the Vatican proves him to have been well informed upon counterpoint, as far as it was then known and practised; he not only applied himself to church music, but wrote motetts; but these are lost, and perhaps would, if we had them, be difficult to decipher. Belonging to this century, also, we have, by the assiduity of the Abbé le Bœuf, the account of a manuscript by Guillaume de Machau. This MS. consists of two volumes of French and Latin poems, and a great number of *lays, virelays, ballades*, and *rondeaux*, all set to music; some for a single voice, others in three and four parts—triplum, tenor, contra-tenor, and a part without title. In the second volume is an entire mass, including the *Credo*, in four parts, which it is believed was sung at the coronation of Charles V. in 1364.

During the fifteenth and sixteenth centuries, the art made but little progress in France. Under Francis I. musicians in France were much less numerous than in Italy, Germany, England, and the Low Countries. The works of Claude de Jeune, who probably ought to be placed with the Flemish school, and of Orlando di Lasso, seem to have been admired and performed at this period in the country in which Josquin was also a favourite. The dearth of writers on the science at this period is no less remarkable. There is, however, one singular work of this period, by Clement Jaunequin, entitled *La Bataille, ou Défaite des Suisses à la Journée de Marignan*, in which imitations of the sounds of battle occur. He published a collection in 1544, called *Inventions Musicales à quatre et cinq Parties*. The masters about this period were Didier Lupi, Guillaume Belleu, Philibert Jambe-de-fer, Sauterne, and Noë Faignent. It is remarkable that some of the worst tyrants have been great patrons of music and its professors; to Nero and our Henry VIII. may be added, for France, Charles IX. At the end of the sixteenth century were some minor artists, such as Jean de Castre, Louis Bisson, Nicholas Duchemin, Francois Roussel, Jean Peroin, and others, who have left collections of madrigals. Francois Eustache de Caurroy, born in 1549, called by his contemporaries *le prince des professeurs de musique*, was maestro di capella to Charles IX., Henry III., and Henry IV., and enjoyed considerable reputation; his works, however, are but little above mediocrity. Jacques Mauduit was a similar instance of mediocrity rising into celebrity. He composed the requiem for the funeral of the celebrated Ronsard, which was afterwards performed at that of Henry IV., whose reign was too short to allow the arts of peace to make much progress in France. His son, who came to the throne at the early age of six years, was a great friend to music, and appears to have kept up what might be called a considerable band for that period. During the reign of Louis XIII., Jean Baptiste Boesset wrote several part songs, as they were called. About the middle of the seventeenth century, Michael Lambert, who died in 1696, appears to have attracted many scholars by his skill in composition. Dramatic music was introduced into France about 1645. In 1660, at the celebration of the marriage of Louis XIV., the opera of *Ercole Amanti* was produced, and the foundation of the French opera was thus laid. At this period Lulli, of Florentine birth, had been patronised by the chevalier de Guise, through whose offices he was put under the best masters of the time. Till the year 1686, in which his last opera was brought out, he seems to have been the idol of the court, and to have been considered in France the ne plus ultra of composers. Compared, however, with the Italian opera of the same epoch, his compositions are not far behind, though it was a misfortune for the country that, for so long a period, everything which was not an imitation of the style of Lulli was considered an inferior production. Instrumental music made but little progress in the seventeenth century. The most distinguished organists were, the three Bournonvilles, and the three Couperins; Charbonières, who died in 1670; Dumont, a good composer of church music, who first introduced violin accompaniments into France; the Abbé de la Barre; and, lastly, Lalande, the most celebrated French composer of ecclesiastical music, at the end of the seventeenth

and beginning of the eighteenth century. Rameau, born at Dijon in 1683, was destined to rouse the French nation, which seemed to have slept since their loss of Lulli. In the space of twenty-seven years after 1733 he produced twenty-two operas, and became so great a favourite with the people that it was dangerous to criticise his works. The time has, however, passed in which his operas would be listened to; and but for his theoretical works, the only solid base of his glory, he would long since have been forgotten. Rameau died in 1767. His school lasted till about 1775, though since 1750 the comic opera has been on the Italian model. Under this, with Dauvergne, Le Borde, Floquet, J. J. Rousseau, Duni, and Philidor, French melody has regenerated; and Monsigny, Gossec, and Gretry completed its improvements. The reform thus effected prepared the French for the reception of the *Iphigénie* of Glück, in 1774, at which time he had Piccini and Lucchini for rivals. These musicians have been succeeded by a school which comprises the names of Berton, Mehul, Boildieu, Kreutzer, and others; and among the Italians who joined their ranks are found those of Cherubini, Spontini, and Winter. In instrumental composition the French have not been so original, though latterly they have considerably advanced, and the names of Auber and Berlioz will at once occur to the reader as great in this department. France is considered deficient in musical literature, and does not attend to its cultivation with the ardour of the Italians and Germans. Their *Conservatoire*, however, is an establishment likely to do honour to the nation; and the work of Choron, entitled *Principes de Composition des Écoles d'Italie*, is alone sufficient to redeem the French from the accusation of wanting musical literature.

English Music.—We are not acquainted with writers in this country of earlier date than those of Italy; but, for the honour of this country (however much we may have been behind Italy in the restoration of other arts), in that of music we were formerly quite on a par with the Continent; and it is singular that in later years we should have lost, and perhaps deservedly, our character among other nations. It is certain that England can boast masses in four, five, and six parts, written by natives, as ancient as those of the Italians themselves; we have also secular music in two and three parts, and in good counterpoint, in the latter part of the fifteenth and beginning of the sixteenth century, about which period the names of William of Newark, Sheryngham, Turges, Tudor, Banester, Browne, and others, are familiar to the English musician. The first named was one of the musicians of Henry VI.; and the compositions of Tudor are known from Prince Henry's (Henry VIII.) music-book. Henry VIII. is known as a composer, from a beautiful anthem in Boyce's collection of cathedral music; and his patronage of Christopher Tye, the composer of *Laudate Nomen Domini*, a motett frequently sung at madrigal meetings in the present day, shows that good music was then esteemed as it ought to be. Marbeck, in 1550, published the whole of the reformed cathedral service to musical notes, and for his exertions as a reformer was nearly being brought to the stake. During the reign of Elizabeth the talents displayed by our countrymen appear to have been surpassed in no other country, and music here was then indeed in its palmy state. Tallis, Bird, Morley, Dowland, and Bull, were the principal composers of the reign: Elizabeth herself must have been no mean performer, if she was able to play the pieces in her virginal book. Though it does not appear that James I. took much delight in music, it nevertheless continued to prosper during his sway; indeed, the compositions of Gibbons were, as pieces of church music, perhaps never surpassed in any age or nation: neither are his secular pieces of inferior character. This reign as well as the preceding was fruitful in madrigal writers as well as composers for the church; among the former were Michael and Thomas Este, Bateson, Ward, Litchfield, Pilkington, Wilbye, Bennett, Farmer, Ford, and others; and among the last Tomkins, Elway Bevin, and Dr. Nathaniel Gyles. In the time of Charles I. instrumental music was coming into vogue: the monarch was a pupil of Cooper (who was wont to be called Coperario), and used to practise the viol-di-gamba. He had a band of performers, eighteen of whom are known, including Nicholas Lanière, the master of it. The most celebrated musicians of this reign were Dr. Wilson, William and Henry Lawes, and Dr. Child, who died in 1697, aged ninety, after having been organist of St. George's chapel, Windsor, during the extraordinary period of sixty-five years. So intent was Charles upon advancing music, that he granted a charter to the most eminent musicians of that day, with many great privileges. The art had been sinking for some years, but its fall was accelerated by the suppression of the cathedral service in 1643; and the only persons of whom we hear during the time of Cromwell were William and Henry Lawes. Though these men were favourites of Milton, and the subject of some of his verses, they were sadly inferior to Tallis, Bird, and Gibbons. During the interregnum the musical flame was chiefly fed at Oxford; but even there, from the year 1646, in which the king was forced to leave the city, after the battle of Naseby, until 1656, it was nearly extinguished. At the Restoration it appeared again to flourish: Child, Christopher Gibbons, Rogers, and Wilson, were made doctors of music at Oxford; the choirs again obtained good masters; and the organs, which had been destroyed by the rage of the Puritans, were again set up, though with difficulty from the scanty supply of organ-builders. Among the musicians who were attached to the court of Charles II. was Henry Purcell, of whom Dr.

Burney says, that he, 'during a short life, and in an age almost barbarous for every species of music but that of the church, manifested more original genius than any musician, under similar circumstances, that any enquiries into the history of the art have yet discovered in any part of Europe.' This truly great man died Nov. 21, 1695, in the thirty-seventh year of his age; his principal contemporaries were Dr. Blow, his master, Pelham Humphreys, and John Weldon. After Purcell's death, some skilful men appeared as amateurs in the service of the church; namely, Doctors Holder, Aldrich, and Creyghton: among the professors were Jeremiah Clarke, Goldwin, and Doctors Croft, Green, Boyce, and Nares. Croft of all these was undoubtedly the greatest; he, like Purcell, was a disciple of Blow: always elegant and simple in his strains, frequently grand and masterly, he has not left a composition that does not exhibit great learning. His death occurred in 1727, in the fiftieth year of his age. Dr. Boyce occupied the void which Croft's death had created; he was a good musician, always pleasing, but rarely grand in his compositions. His contemporary, Jonathan Battishill, wrote some fine compositions for the church, and prepared the way in glee writing for a race of English musicians who are an honour to their country. The reader will recognise the truth of this assertion when he glances at the names of Alcock, Arne, Attwood, W. Beale, Callcott, Dr. Cooke, Robert Cooke, Crotch, Danby, James Elliott, Harington, Horsley, Thomas Linley, the earl of Mornington, Shield, Stafford Smith, Spofforth, the Wesleys, &c. In dramatic and symphony writing, we regret to say, England is still in her infancy, though Sterndale Bennett, Macfarren, and Balfe are well-known names in these branches of the art.

Chinese Music.—The Chinese have had a system of music from a most remote period, and in its scale it seems to have more resemblance to the Grecian than any other to which it could be compared. From the time, it is said, of Yao and Chun, which their chronology would carry back two-and-twenty centuries before Christ, they have had what they call eight species of sounds: 1st. The sound of dried skins, such as drums; 2nd. The sound emanating from stone, called *king*; 3rd. That of metal, as bells; 4th. That of baked earth, called *hiven*; 5th. That from silk, called *kin* and *che*; 6th. That from wood, called *ya* and *tihou*; 7th. That from bamboo, such as flutes, called *koan*; 8th. That from the gourd, called *cheng*. Their scale consists of fourteen notes, of which the seven middle notes correspond to our g[illegible]ut from *f* upwards. They seem unacquai[illegible] with harmony.

Hungarian Music.—About the ninth century the Hungarians left Asia to settle in Europe, when they conquered the country that bears their name. Like all the Asiatics, they were attached to music, and at first, doubtless, used only Asiatic instruments: these were nearly all wind instruments, and consisted of the trumpet, the flute, the cymbal, and several others. Till the time of Mathias Corvin it was in a state of mediocrity. Under Ladislas and Louis II. music was cultivated with great care; their national songs were, however, their only vocal music till the time of Stephen, king of Hungary, when the ecclesiastical chant appears to have been introduced. From a diploma of Bela III., A.D. 1192, that prince, it appears, sent an envoy to Paris to be instructed in melody; being induced to do so, perhaps, by his second wife Margaret, who was daughter of Louis VII. of France.

Theory and Practice of Music.—Music is both an art and a science. Its study comprises three distinct branches: namely—

1. The science of *acoustics*, treating of the philosophical nature of musical sounds, and of their relations to each other.

2. Musical *composition*, which is of itself both an art and a science. This is what is usually understood by the *theory* of music. And,

3. The art of *performing* music, either with the voice or on instruments. This is entirely of a practical nature.

The last of these can properly be studied only by personal application under the direction of a teacher, and therefore it is out of our province to notice it here, further than to say that the performance of music requires a knowledge of composition, so far as to understand perfectly the intentions of the composer; while a still further acquaintance with theory is highly advantageous in promoting the intellectual character of the singing or playing.

On the science of Acoustics, also, which is both elaborate and profound, our remarks here must be necessarily few. Musical sounds are produced by vibrations of the air, which may either be generated in the air itself, as by a flute or organ pipe, or transmitted to it by some vibrating body, as the reed of a clarionet, or a pianoforte or violin string. These vibrations may be counted, by certain philosophical means: and it is found that as they are quicker or slower, i.e. as there are more or fewer of them in a given time, the note sounds to us more acute or more grave; so that a certain note always corresponds to a certain number of vibrations per second. The position of a note in the scale of acuteness and gravity is called its *pitch*, and it follows that a higher pitch involves a greater velocity of vibration, and vice versâ. It might be supposed that a general consent of musicians would have established a uniform pitch, by which any certain note might be positively defined, so as to give the notes of music a positive and definite position; but unfortunately this is not so; and consequently it is impossible to do more than define them approximately. The note called middle C on the pianoforte, and marked thus

thus , or thus

usually assumed, in theoretical works, to cor-

respond to 512 single vibrations per second; and this was till late years the pitch adopted in practice, but modern custom has made it a little higher; the C now established in France has 522 vibrations, and in England and Germany 528 vibrations per second.

When two notes are sounded together, it is found that their effect on the ear has a remarkable relation to the proportion between their respective velocities of vibration; and this principle gives rise to the acoustic doctrine of intervals, which may be briefly stated as follows. If the numbers of vibrations of two notes in a given time be as 1 : 2, the second note will be of the same name as the first, but an octave higher; so that the interval of the octave is expressed by the vibrational relation 1 : 2. If the respective numbers of vibrations are as 2 : 3, the second note will be a perfect fifth higher than the first, i.e. the interval of the fifth corresponds to the acoustical relation of 2 : 3, and so on.

Acoustical Relations of Musical Intervals.

Notes	Intervals from the Lowest Note	Ratio of Vibrations with those of the Lowest Note	Single Vibrations per Second
C	Octave	1 : 2	1056
B	Major 7th	8 : 15	990
B♭	Minor 7th	5 : 9	950
A	Major 6th	3 : 5	880
A♭	Minor 6th	5 : 8	845
G	Fifth	2 : 3	792
F♯	Tritone	18 : 25	733
F	Fourth	3 : 4	704
E	Major 3rd	4 : 5	660
E♭	Minor 3rd	5 : 6	634
D	Major 2nd	8 : 9	594
D♭	Minor 2nd	15 : 16	563
(Middle) C	Unison	1 : 1	528

The above table will show these relations for all the principal intervals in the scale.

It thus appears that there is some curious analogy between an agreeable effect on the ear and a simplicity of proportion in the number of vibrations, those intervals which have the simplest ratios being naturally the most perfectly harmonious, while in proportion as the complexity of the ratio increases, the effect of the combination becomes more discordant.

When musical sounds are produced by stretched strings, it is found that if the weight and the tension of the string remain the same, the number of vibrations will be inversely in proportion to the length of the vibrating portion; so that a string half the length of another will give double the number of vibrations in a given time, and will therefore sound an octave higher. And it follows that all the ratios we have given, as to the number of vibrations, will apply *reciprocally* to the length of strings producing the notes referred to; i.e. the ratio of length of two strings to produce a note and its fifth will be as 3 : 2 respectively, and so on.

We cannot follow this subject further, but must refer for more ample information to books on Acoustics, of which Chladni's *Akustik* and Helmholtz's *Lehre von den Tonempfindungen* are the most renowned.

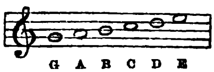
We now come to treat, somewhat more at length, of the second division of the subject, namely, *Musical Composition*; which comprehends, first, the explanation of the peculiar symbols used, or what may be called the language in which music is expressed; and secondly, the rules usually laid down in order to produce grammatical and effective musical composition.

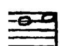
All musical ideas are expressed by means of *notes* on a *staff*, i.e. five equidistant horizontal lines, on or between which the notes are placed. The *gamut* is a table whereon these notes are placed; and their relative situations as to acuteness or gravity of tone are ascertained by *clefs*. The names of the notes, as originally

		Clef.	Ancient Scale.						
Treble or highest	E								la
	D							la	sol
	C							sol	fa
	B							fa	♮ mi
	A						la	mi	re
	Γ						sol	re	ut
Tenor or mean	F						fa	ut	
	E					la	mi		
	D				la	sol	re		
	C				sol	fa	ut		
	B				fa	♮ mi			
	A			la	mi	re			
	G			sol	re	ut			
Bass or lowest	F			fa	ut				
	E		la	♮ mi					
	D		sol	re					
	C		fa	ut					
	B		mi						
	A		re						
	Γ	(Gamma)	UT						

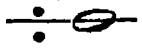
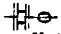
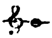
or

Modern Scale.

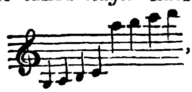




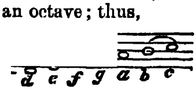
laid down by Guido d'Arezzo, were *ut*, *re*, *mi*, *fa*, *sol*, *la*, the lowest of these being the gamma of the scale. He had only six notes in his scale, which he repeated in different keys, so that some notes, really the same, had different names, according to the key to which they were considered to belong. Modern musicians, abolishing this distinction, have added a seventh note to complete the octave, and have used as equivalents the first seven letters of the alphabet. The diagram given in the preceding page will exhibit a comparison between the ancient and modern modes.

From this diagram it will be seen that the bass clef, also called the F clef, makes the notes on the line between the dots  F, whence reckoning is made upwards or downwards; that the tenor or C clef makes all the notes on the line between the cross or horizontal bars  C; and that the treble or G clef makes all the notes on the line round which the character turns  G; and it is to be observed that these several clefs may be put on any lines of the staff notes, which then take the name F, C, or G, as the case may be. Thus,

The second, fourth, and seventh of these, however, are now no longer used. The first is used for the bass voice and all bass instruments; the third for the soprano voice; the fifth for the alto voice and the viola; the sixth for the tenor voice; the eighth for the violin and other treble instruments. The eighth and first are used for the pianoforte. The eighth is also now used for treble voices.

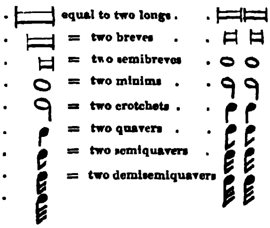
One of the most important ends gained by the use of these clefs is the avoidance of notes running off the staff, which they otherwise would do, and what are called *ledger* lines would be wanted; thus, , where the ledger lines are those upon which the notes out of the staff are placed. The lines of a staff are reckoned upwards; thus the lowest line is called the first, the lowest but one the second, and so on. In the pianoforte the C nearest the middle of the instrument is the note of the tenor or C clef; the G above it to the right is the treble or G clef; and the F below it to the left is the F or bass clef note.

When to the seven primary notes (see diagram) another is added above, the arrangement is called an octave; thus,

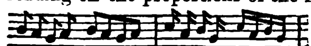


After which if more be added, either upwards or downwards, it will be but a return to similar notes either more acute or more grave in pitch; that is, an octave above or below them respectively. This, which is called the *diatonic scale*, has between its notes seven intervals, of which those between *c* and *d*, *d* and *e*, *f* and *g*, *g* and *a*, and *a* and *b* are equal, and are called *tones* or *whole tones*; whilst those between *e* and *f*, and *b* and *c*, are *semitones*. To enquire how nature has implanted on the ear dissatisfaction from any other position of these semitones in the scale of the octave, is not the object of this treatise. That it is so is certain; and the most careless whistler could not alter the scale without exertion. The scale is also divided into two *tetrachords*, from *c* to *f* and from *g* to *c*: each of these consists of two tones and a semitone. All *melody* or *air*, which is an artful succession of tones, depends on a right perception of the places of the semitones.

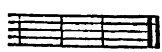
By the particular *form* of a note, its duration, or the length of time during which it is to be held on, is known. There are nine of these forms, which are exhibited in the subjoined table; the first three are now rarely used, though in old ecclesiastical music they are constantly met with.



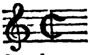
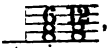
The large . . .		equal to two longs .	
The long . . .		= two breves .	
The breve . . .		= two semibreves .	
The semibreve . .		= two minims .	
The minim . . .		= two crotchets .	
The crotchet . . .		= two quavers .	
The quaver . . .		= two semiquavers .	
The semiquaver . .		= two demisemiquavers	
The demisemiquaver .			

The notes with hooks appended to their tails are frequently grouped together; this does not alter their value, but it assists the eye in reading off the proportions of the notes. Thus, . If

Detached Grouped Detached Grouped

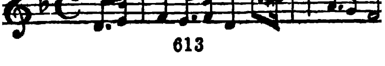
a dot be added to the right hand of any note, thus , it increases its duration exactly one-half. The duration of a note is measured by the musician from habit, and is regulated by *beating time*; that is, by the elevation and depression of the hand or foot quicker or slower according to the nature of the music performed. A musical piece is divided into *measures*, which are equal portions of time; and the vertical lines which so divide it are called *bars*; single lines taking merely that name, and the two thick ones at the end of a strain *double bars*, thus, 

Every measure must contain a certain number of notes according to the time marked at the beginning of the movement; and that time is of two sorts—*common time* and *triple time*—in which two all others originate. Common time is that which has an even number of beats in each bar, as two, four, or eight. Those common times in which a semibreve is the measure are

marked by a C after the clef at the beginning of the staff; thus,  When the C has a bar through it, thus,  it denotes a quicker measure, to be beaten in minims, whereas the simple C time is usually beaten in crotchets. It is called *alla breve*. The other characters of common time are , signifying that there are two crotchets, six quavers, or twelve quavers, in the bar, of which 4 and 8 (the denominators respectively) make a semibreve. The first and second of these have two, and the third four beats in a bar. Triple time is so called from the bars being divisible into three parts: it is beat with the hand down at the beginning of the bar, raised a little in the middle, and quite up at the close of it. In this time also the denominator of the figures placed at the beginning of the staff is a fraction of a semibreve; thus, if 2 be the denominator, the measure is a minim, because two minims make a semibreve; if 4, the measure is a crotchet; and so on. Hence  signifies three minims in a bar;  three crotchets;  three quavers. So again with multiples of 3 for the numerator, as  nine quavers, ___ nine semiquavers. It is easy to recollect that the denominator of the fraction always expresses the division of the semibreve, and the numerator the number of these divisions in a bar; but the sense of the music must also be consulted, for though, for example, $\frac{3}{4}$ and $\frac{6}{8}$ are arithmetically the same fractions, the first is triple, and the second common, time.

There is a certain stress laid on some part or parts of every bar, which is called *accent*; hence each bar or measure is divided into accented and unaccented parts: the accented are the principal, and those on which the pathos and spirit mainly depend. The beginning and the middle or the beginning of the first half of the bar and the beginning of the latter half, in common time, and the beginning or first of three notes in triple time, are universally accented parts of the measure; so the first and third crotchet of the bar are on the accented part of the measure in common time. In triple time, where the notes, as we have explained, go by threes, the note in the middle is unaccented, and the first and last accented; the accent, however, on the first is so preponderant, that the last is almost accounted as though it had none. It is on account of accent that it is frequently necessary to begin a movement with only part of a measure. Thus in the Welsh tune *Griffith ap Cwnan*—

(As written.)



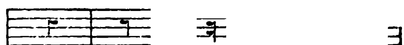
it will immediately be seen that the alteration of the accent entirely changes

(As changed in accent.)

the character of the air. An abnormal accent is often laid on some notes of the bar which are usually unaccented; this is called *emphasis*, and its employment with skill and taste contributes much to the beauty and originality of the piece. When the last note of a bar (as in the last bar of the lower example) is connected with the first of the following bar, so as to make only one note of both, it is called *syncopation*. This is also sometimes used in the middle of a measure.

A *rest* is a pause or interval inserted when silence is required in the part to which it is written, which silence is to be preserved during the time denoted by the species of rest used. The following are the rests used:

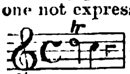
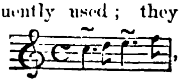
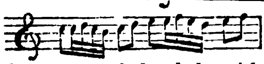
Semibreve Minim

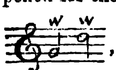


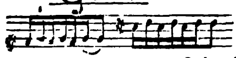
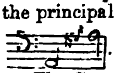
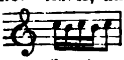
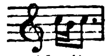
Crotchet Quaver Semiquaver Demisemiquaver

In modern music it is necessary that we should use other sounds in the octave besides those of the simple diatonic scale; and an expedient is therefore wanted by which the places of the diatonic notes may be raised or depressed the value of a semitone. The former, that is raising them, is effected by placing sharps before them, thus ♯; and the latter by means of flats, thus ♭. If we want to restore any note that has been thus treated to its original place, it is effected by means of a natural, thus ♮. Two other characters are also used—the double sharp, thus ×, which raises a note two semitones; and the double flat ♭♭, which equally depresses it. Upon keyed instruments, such as the pianoforte and organ, the sharps and flats are represented by the short black keys, and there is no distinction between D♯ and E♭, and such want of distinction is an imperfection in the instrument; for there is not a strict mathematical equality between the semitones of the diatonic scale. A number of these flats and sharps placed at the beginning of a staff affects all the notes of the line or space on which they are placed, and are termed the *signature*. If, in addition to these, in the course of a movement any others occur, they are termed *accidental*, and only affect the notes which they immediately precede, and any repetitions of them in the same bar; but if in the same bar any note, after having been accidentally raised, on being repeated is preceded by a natural, such natural restores it to its original place.

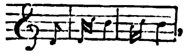
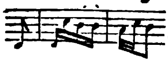
The ornaments of musical melody are called *graces*; of these the principal are the *appo-*

giatura, the *shake*, the *turn*, and the *beat*; with the *mordente*, *beat*, *slide*, and *spring* peculiar to the Germans; those of musical harmony are the *arpeggio*, the *tremando*, &c. The appogiatura, which always occurs on the accented part of the measure, is a small note placed before a large one of longer duration, which it usually deprives of half its value; thus, , wherein the small notes are appogiaturas. Occasionally, the appogiatura is of less duration than above stated. The shake is a quick alternate repetition of a note with the note above it, the mark *tr* being placed on the lower, and the upper one not expressed; thus, , performed . When there is a series of ascending or descending shakes, the Italians call it *una catena di trilli*. What the Germans call the *passing shake* is thus marked over the note where it is intended, thus , performed . The mordente of the Italian school is used in a similar way; thus , performed . The turn employs the note above and that below in the following way, , performed . The inverted turn, thus marked , turns from the note below that marked instead of above it. Turns on dotted notes are very frequently used; they are written as follows, , performed . The beat is the reverse of the shake without the turn, and is generally made at the distance of the semitone below; hence all the natural notes, except C and F, require the note below them to be accidentally sharpened for the beat; thus,

,

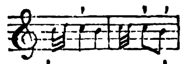
performed . The half-beat is most frequently used in the bass, and is very similar to the acciacatura of the Italians. The inferior note is struck only once, and at the same time with the principal note; but is immediately quitted, as . The Italians use the degree above. The German mordente is a beat commencing with the note itself, and is either long or short; thus,  . This differs from

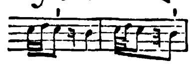
(long) (short)

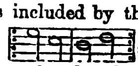
the mordente already described by being made with the next degree below. The Italians use the degree above. The German beat consists of two small notes, forming a skip, descending one degree upon the principal note; written thus , performed . Naumberger calls this grace a double appogiatura. The German slide consists of two small notes, which move by degrees; written thus,

,

performed . The German spring, like the Italian mordente, consists of two small notes, sounded distinctly; thus

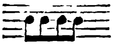
,

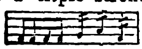
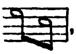
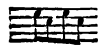
performed . It is the practice of the composer to mark, where necessary, the occasional alteration of these graces by sharps, flats, or naturals. The graces that belong to harmony are, the *tremolo*, or reiteration of one note of a chord; the *tremando*, or general trembling of the whole chord; and the *arpeggio*, which is an imitation of the harp, the notes of the chord being struck in quick and repeated succession.

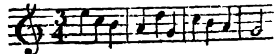
The following characters are also used in Music: The *pause*, which, placed over a note, signifies that a long continuance of the sound is to be made on that part of the measure, and is equally effective when placed over a rest; the *repeat*, which is a sign placed to show where the performer must return to repeat the passage—the Italians call it *il segno*; the *direct*, placed at the end of the staff on the line or space which the following note will occupy. The dots which are found in the inner side of bars show that the measures or bars included by them are to be repeated; thus, , shows that these two bars are to be played twice over, the same object being sometimes effected by writing the word *bis* over them.

We have already mentioned the single and double bar; all that we have to add on them here is, that as every bar or measure contains a certain number of notes, so every *strain* consists of a certain number of measures, which are terminated by the double bar.

Expression, in music, is indicated by the following marks: The *tie*, which is a convex

line over ⌒ or a concave line under ‿ two notes on the same line or space, uniting them into one. It is also used to express syncopated notes where the bar divides them. The *slur* is a similar line, used over notes not on the same lines or spaces, showing that such notes are to be played smoothly or *legato*; and in vocal music it also means that all the notes connected by it are to be sung to the same syllable. The *dash* is a small vertical stroke | placed over notes that are to be distinctly marked, or, as it is termed, played *staccato*. Sometimes, instead of this, the *point* is used, though it is mostly employed to distinguish those notes from which an intermediate effect between the slur and dash is wanted, yet uniting the one and the other; thus, . The other marks of expression are the *crescendo* <, by which the sound is to be increased from soft to loud; the *diminuendo* >, which is exactly the reverse of the last—the union of these two <> indicating that the part is gradually altered from soft to loud in the middle, and then to soft again; and the *rinforzando*, for which smaller marks of the same sort are used, > or <, which increase or diminish the sound so marked.

In order to save time in writing and copying music, the following abbreviations are used: A single stroke placed over or under a semibreve, or through the stem of a minim or crotchet, divides it into quavers, a double stroke into semiquavers, and a triple stroke into demisemiquavers; thus, . Another kind of abbreviation is much used in modern music, and is effected by grouping the stems of minims like those of quavers; thus, , performed .

Melody, which will be perhaps better understood by the term *tune*, is a particular succession of sounds in a single part, and is produced by the voice or an instrument. The artful manner of introducing the notes of different lengths, succeeding one another at intervals pleasing to the ear, is one of the qualities distinguishing the musician; the other being the successful accompaniment of these single sounds by others, according to the laws of harmony. The laws of harmony may be learnt, and so may certain general rules of melody; but the art of producing pleasing melodies is a natural gift, which cannot be supplied by any kind of education. Melody has two motions—either by degrees or by skips: by the former when it moves to the line or space immediately above or below it; and by skips when one or more degrees are omitted between the preceding and following note. The following example shows each motion: .

The distance between any two notes is called an *interval*.

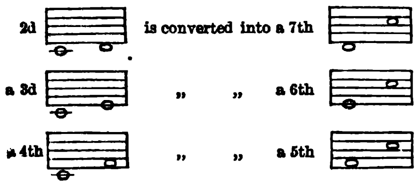
We have already described, in the first part of this article, how intervals are theoretically defined by the ratios of the vibrations of the notes producing them, and how they may be represented by the comparative lengths of stretched strings; but it will be as well here to add a few words of explanation of a more practical nature. It is customary to measure intervals from the lower of the two notes, and the general name of the interval is determined by the number of degrees contained between them, reckoning according to the names which the notes bear. Thus, from C to D is an interval of a second, from C to E a third, from C to A a sixth, and so on. But intervals of the same *general* name may have different values, and therefore different *special* names, as the limiting notes are severally sharp, flat, or natural; thus, from C to D♭ is a *minor* second, from C to D♮ is a *major* second, and from C to D♯ an *augmented* second, and so on. Referring the intervals to the keys of the pianoforte, and taking as the unit of measure the semitone, i.e. the distance from any one key to the next above or below, we have the following values:—

Name of Interval	No. of Semitones	Example	
Unison	0	C	
Minor second	1	C	to D♭
Major second (this is also called a whole tone) .	2	C	to D
Minor third	3	C	to E♭
Major third	4	C	to E
Perfect fourth	5	C	to F
Augmented fourth, sharp fourth, or tritone . .	6	C or F♮	to F♯ to B
Imperfect or diminished fifth	6	C or B	to G♭ to F
Perfect fifth	7	C	to G
Minor sixth	8	C	to A♭
Major sixth	9	C	to A♮
Minor seventh	10	C or G	to B♭ to F
Major seventh	11	C	to B♮
Octave	12	C	to C

The above fourteen intervals are given in the following synopsis:—

By inserting the semitones between these intervals, the number which we have above stated in each will be easily discovered. There are also some other intervals which occur frequently in modern melodies, and which are

called augmented or diminished, as the case may be ; thus, the augmented or superfluous fifth  consists of one semitone **more than the perfect fifth ;** the augmented or **extreme sharp sixth**  consists of one semitone more than the major sixth; the diminished seventh  consists of one semitone less than the minor seventh; and so on. When the lower note of any interval is placed an octave higher, or the higher note an octave lower, it is called *inversion*. Thus,



By this operation major are converted into minor intervals, and the converse; for instance, the major third becomes a minor sixth, and so on.

There are three scales occasionally used in music: the *diatonic*, the *chromatic*, and the *enharmonic*.

The diatonic is the most simple and natural scale. It has already been described; but we may add the following example:—

Diatonic Scale of the Key of C Major.

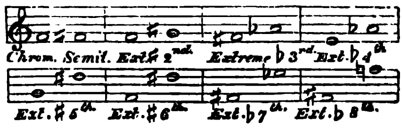
C D E F G A B C

Whole tone — Whole tone — Semitone — Whole tone — Whole tone — Whole tone — Semitone

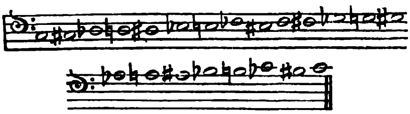
It will be at once seen that this scale, for the key of C, corresponds with the white keys on the pianoforte, no black ones being necessary to its formation.

The chromatic (which, according to some, takes its name from the Greek word χρῶμα, *colour*, because the Greeks distinguished it by different-coloured characters; according to others, because, holding the mean place between the diatonic and enharmonic system, it was like colour between black and white; or, as others say, because, like colours in painting, it embellishes the diatonic by its semitones) usually ascends by sharps and descends by flats, as follows:—

From this it appears that the chromatic scale consists of thirteen notes, and it gives rise to a distinct species of intervals called *chromatic*. For example, the *chromatic semitone* is the interval between any note and the same depressed by a flat or raised by a sharp. Also, the *extreme sharp second* consists of a tone and a chromatic semitone, being composed of two degrees. Some chromatic intervals are exhibited in the subjoined synopsis:—



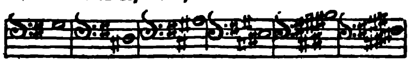
The enharmonic scale is a series formed by uniting the ascending and descending scale of the chromatic genus We subjoin a diagram of it; but it is hardly to be called a scale; it is merely a list or schedule of the various notes which are to be found in the octave.



As in oratory there is a principal subject on which the speaker constantly dwells, and to which, after diverging from it, he always returns; so in music there is one sound in which the piece usually begins and ends, which regulates the rest, and to which regard must be had in all the other sounds of the piece: and this sound is called the *key*, the *key note*, or *tonic*. From the diatonic scale we have seen that the semitones lie between E and F, and B and C; the key note being C. Now if we wish to make G the key note, it is clear that without some contrivance the notation of the scale from G to its octave will throw one of the semitones out of its place; namely, that between E and F, which, instead of being, as it ought to be, between the seventh and the octave, is between the sixth and the seventh. It is obvious, then, that if we raise the natural F a semitone by means of a ♯, we shall restore the semitone to a situation similar to that which it held in the key of C. By comparing the subjoined scales, this will be more distinctly seen.

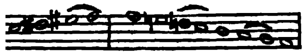
Now if D be taken as the key note, we shall find it will be necessary to sharpen the C as well as the F, in order to bring the semitones into the places which they ought to occupy in the octave; and we shall have two sharps. In order to save the constant repetition of these

sharps, it is usual to put them at the beginning of the staff, where they are called *signatures*, each signature denoting the key of the note written after it, thus,



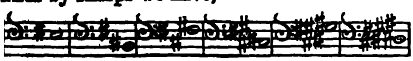
In the same way the keys bearing flat are marked, saving that the note B bears the first flat, as follows:—

Besides these scales, which are all constructed with the major third, and are therefore called major keys, there is a scale, constructed from the natural notes, whose third is minor; thus,

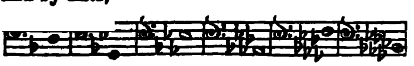


In this scale it must be observed, first, that the places of the semitones are different; and, second, that the ascending scale always requires the seventh to be sharpened, though it is not sharpened in the descending scale. The sharp in question is, however, always omitted in the signature, and marked accidentally where the melody requires it. It must also be noted, that between the F♮ and G♯ a harsh chromatic interval, called an *extreme sharp second*, would occur; to avoid which the sixth is also sharpened, by which the scale of the minor mode has two notes different from the signature; but in the descending scale no accidentals are required.

Major and minor scales which have the same signatures are denominated *relative*. Thus the relative minor key of A is F♯; in which case the tonic or key note of the minor mode is found to be the sixth note ascending of the major scale bearing the same signature; and the tonics are always one degree below the last sharp of the signature, but in flat signatures always the third degree above the last flat. Thus by sharps we have,



and by flats,

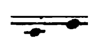


The change of a melody from its original to a higher or lower pitch is called *transposition*, and this may be effected by altering the signature according to the pitch of the new tonic or key note. *Modulation* signifies the proceeding naturally and regularly from one key to another. Every scale is immediately connected with two others: one on the fifth above, the other on the fifth below or fourth above. These were called by Dr. Boyce *attendant keys*. Minor scales have also their attendant keys, the chief one being the relative major

We here subjoin the names given to certain notes in the scale as peculiarly marking their character. 1st. The *tonic*, or key note, is the chief sound upon which all regular melodies depend, and with which they all terminate. All its octaves above and below are called by the same name. 2nd. The *dominant*, or fifth above the key note, is that sound which from its immediate connection with the tonic is said to *govern it*; that is, to require the tonic to be heard after it, at the final cadence in the bass. 3rd. The *subdominant*, or fifth below the key note, is also a species of governing note, as it requires the tonic to be heard after it in the plagal cadence. It is the fourth in the regular ascending scale of seven notes, and is a tone below the dominant; but the term arises from its relation to the tonic, as the fifth below. These three principal sounds are the radical parts of every scale of the minor as well as the major. 4th. The leading note, or sharp seventh of the scale, is in Germany called the *subsemitone* of the mode: it is always the major third above the dominant, and therefore in the minor scales requires an accidental sharp or natural whenever it occurs. 5th. The *mediant*, or middle note between the tonic and the dominant ascending, varies according to the mode; being the greater third in the major scale, and the lesser third in the minor scale. 6th. The *submediant*, or middle note between the tonic and subdominant descending, varies also according to the mode; being the greater sixth in the major scale, and the lesser sixth in the minor scale. 7th. The *supertonic*, or second above the key note, has seldom been distinguished in England by this or any other appellation.

Harmony consists in the combination of two or more sounds or melodies heard at the same moment. A *concord* is an agreeable and satisfactory relation of two sounds as respects the ear. Concord is therefore included under the term *harmony*, though harmony comprehends the agreement of a greater number of sounds than two. When two sounds heard together are unsatisfactory to the ear, the relation between them is called a *discord*. The concord then may be called a harmonical interval, and the discord an inharmonical one; yet by the proper interposition of discords the harmonies of a passage receive a lustre and value from the contrast. They must, however, as we shall presently show, be properly *prepared* and *resolved*, as it is technically called. The union of any sound with its third (major or minor) and its perfect fifth is called a *common chord*; to which if the octave to the sound be added, we have a combination of four sounds in the harmony; thus,

Major



Minor

So long as in these chords the C or the A remains the lower note, the chord is called the common chord of C or A respectively; but the

moment the position of the lower note is changed, the name of the chord also changes. Thus if E of the common chord of C be used as the lowest or bass note, thus,

, the chord is called the chord of the *sixth*; because the key note is then the interval of a sixth upwards from the bass note, and that sixth has for its accompaniment a minor third from E to G.

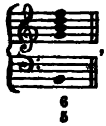
If G be now placed at the bottom and used as the bass note, thus,

, the key note is an interval of a fourth above the bass, and the chord is called the chord of the *sixth* and *fourth*, as the example shows. From this it is manifest that the sixth and sixth and fourth are no more than inversions of the common chord, having the same note C for their expressed or understood bass, which is called the *fundamental bass*, because it is that on which they are founded; and the same arrangement equally exists in the common chord with a minor third. The common chord is expressed shortly thus, $\begin{smallmatrix}5\\3\\8\end{smallmatrix}$, $\begin{smallmatrix}5\\8\\3\end{smallmatrix}$, or $\begin{smallmatrix}8\\3\\5\end{smallmatrix}$; but in figured bass, the omission of all figures denotes the common chord. The second example, or chord of the sixth, is merely figured with a 6; and the third example, where G is the lowest note, is denoted by the figures $\begin{smallmatrix}6\\4\end{smallmatrix}$.

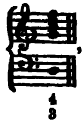
Of discords, the most simple is the minor seventh, or, as some call it, the *dominant seventh*; because in the natural scale it occurs only on the fifth or dominant of the key, and requires that part in which it occurs always to descend one degree. We here give its full accompaniment of four real parts:

. As in the common chord either of these four sounds may be placed as the bass or lower note of the chord, yet as with C in the common chord the fundamental note of it will be G; B being a third, D a perfect fifth, and F a minor seventh; thus,

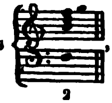
; in each of which cases it would carry the figure 7 below it. When B becomes the bass note, as



, the chord by inversion consists of a minor third, an imperfect flat or false fifth, and a minor sixth, and is, as in the example, figured $\begin{smallmatrix}6\\5\end{smallmatrix}$. If D be next taken as the bass note, thus

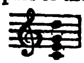


, the chord consists of a minor third, perfect fourth, and major sixth, and is, as in the example, figured thereunder $\begin{smallmatrix}4\\3\end{smallmatrix}$ or $\begin{smallmatrix}6\\4\\3\end{smallmatrix}$. If F be used for the lower or bass note, thus



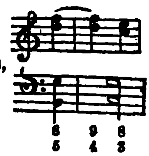
, the chord is composed of a major second, sharp fourth, and major sixth, and is figured $\begin{smallmatrix}4\\2\end{smallmatrix}$, or $\begin{smallmatrix}6\\4\\2\end{smallmatrix}$, or simply 2. From these observations it appears, therefore, that the last three chords are properly called derivatives of the minor seventh when accompanied with a major third and perfect fifth.

Besides the chords within the compass of the octave, there is the ninth; thus,



When used in a composition of four parts, and marked by a single 9, it has the accompaniment of a third and fifth; thus,

Frequently, however, it is accompanied by a fourth and fifth, and then is marked with a double row of figures; thus,

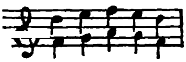
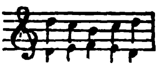
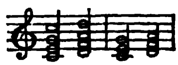


When the composition is in only three parts, the fifth is not used. With the third and fifth as an accompaniment, the ninth becomes then an appogiatura, continued in the place of the eighth. The ninth has two inversions: one of them figured with a seventh on the third of the fundamental note; the other figured with a fifth and a sixth on the fifth of the fundamental note.

When any figures are dashed through, thus, $\not{4}$, $\not{6}$, it indicates that the intervals are to be sharpened.

Before leaving this part of the subject, we subjoin, as properly belonging to it, what is called the harmony of the scale; that is, the accompaniment which it carries in ascending and descending:—

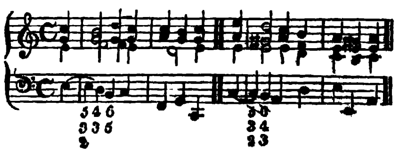
Composition is the art of joining and combining concords and discords in such a manner that their succession and progression may be agreeable to the ear. It may be here mentioned that melody being chiefly the business of the imagination, its rules serve only to prescribe limits to it. But harmony is the work of the judgment; and its rules are more certain and extensive, and more difficult in practice. A person, indeed, unskilled in music may by chance make a piece of good harmony; but a person of judgment does it with certainty. In harmony, the invention has not so much to do; for the composition is conducted from a nice observation of its rules, assisted also by the imagination. It is not to be expected that in the compass of this article space can be afforded for a complete treatise on this part of the subject; all that we propose is to present to the reader some of the leading rules of the science.

The different motions of the parts which constitute harmony may be *direct* or *contrary*. In the former the parts move the same way, ascending or descending. In direct motion, the parts move the same way, ascending or descending,  In contrary motion, one of the parts rises whilst the other falls,  The latter is preferable. As regards the motions and successions of concords: First, octaves and fifths must not be consecutive in direct motion. This for instance is very bad, , and it may be avoided by giving the passages contrary motion; thus, . Second, unnecessary and distant skips must be avoided as much as possible, and the chords should be kept as close and as much connected as may be. Third, false relations, such as the extreme sharp second, must be avoided, unless the same be required for the purpose of expressing some particular effect. Fourth, the regular motion of the different parts in harmony must be observed: sharp intervals should ascend after the sharp, whilst minor or flat intervals must descend after the flat. In observing this rule, however, that of avoiding consecutive octaves and fifths must nevertheless be observed; and it may also be neglected where certain effects are required. It is customary for a composition to begin with one of the concords of its key note, and it should end in the key note with its common chord for the harmony. To these we may add, that you must not go from an imperfect concord to a perfect octave or fifth by similar motion; such passages being said to contain *hidden* octaves or fifths, which will be seen by filling up the diatonic degrees through which one of the parts is conceived to pass.

We proceed to give a few remarks on the harmonic use of the intervals; but for the more complete developement of the laws of harmony, special treatises on the subject must be referred to.

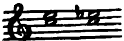
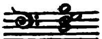
In the *second*, the lowest note is the discord. It may be *prepared* in any concord, and must descend to the resolution,

The *preparation of a discord* is effected by taking care that the note which is the discord is heard in the preceding harmony, its *resolution* being its descent either a tone or a semitone, according to the mode, after it has been struck. Those seconds are called *transient* which are introduced without preparation on the unaccented part of the bar, thus, ; and if these transient seconds be removed to the accented part of the bar, they then become appogiaturas. When the second is attended by the fifth and third, it becomes a chord of four real parts, and retards the chord of $\begin{smallmatrix}6\\4\\3\end{smallmatrix}$ or the $\begin{smallmatrix}6\\5\end{smallmatrix}$; and if the third be sharp, the minor mode is indicated.



A chord is said to have four real parts when it contains four sounds without octaves or unisons: a concord can only have three real parts. When the second is attended by the fourth and fifth, either the fifth or the fourth must be prepared; and it becomes the chord of the fifth and sixth at the resolution of the second by the bass.

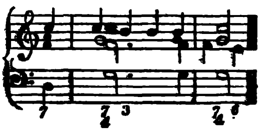
The second accompanied with the sixth and fourth is a chord of four real parts, three of them forming a common chord above the bass, which being the discord must be resolved by a descent to the next degree: the sharp fourth usually ascends,  The second is also accompanied with the fourth and sharp seventh, which, when introduced upon a resting bass, allow all the intervals when struck to ascend,  When, however, the bass moves, it is usual to prepare the upper parts, .

The third major or minor, , is an agreeable concord; of which it is to be noted that two minor thirds in succession are better than two majors, but mixed thirds in succession are most pleasant to the ear; indeed, an octave of major thirds is extremely unpleasant. The third is sometimes accompanied by a fourth and sixth, . That species of it in which the third is minor, the fourth perfect, and the sixth major, is as elegant in effect as the seventh, from which it is derived. The following is an example:

Accompanied by the fifth, the fourth is a discord much used. When introduced on a resting bass, it resolves into the third; and its effect is so similar to that of the ninth, that they are frequently introduced alternately.

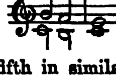
The chord of the fourth accompanied by the sixth is of great use in harmonical progressions; and when preceded by the common chords to the key note and fourth of the key, and succeeded by the common chords to the fifth of the key and the key note, it forms one of the terminations to a musical period called the fourth and sixth cadence; thus,

When the seventh accompanies the fourth, and the latter is followed by the chord of the third, fifth, and seventh, either the fourth or seventh, or both, should be in some part of the chord preceding it. In the following example both the fourth and seventh are prepared and resolved:

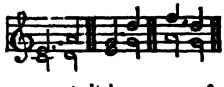
 The fourth and seventh descend to the resolution, and generally resolve after each other.

The interval of the sharp fourth, which has been before mentioned, is a minor semitone more than the perfect fourth, and a major semitone less than the perfect fifth. Its natural resolution is that the bass shall fall a degree, and the upper part rise one, by which the two parts meet in a minor sixth. It is of very great use in modulation, as you can, by introducing it upon the key note, always change the mode you are in, as in the following examples: . In four parts the sixth and second are taken with it.

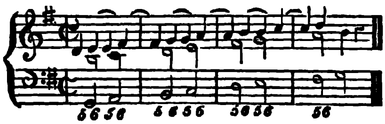
The interval of the imperfect fifth is a minor semitone less than the perfect fifth. In using this chord the highest note falls and the lowest one rises, so that they meet in a major third; thus, . In four parts it is accompanied by a third and sixth, .

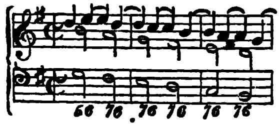
The fifth is the next interval which we have to consider; of this we have already said that two perfect fifths cannot follow each other, except by contrary motion. A false fifth may succeed a perfect fifth,  When any note moves to a fifth in similar motion, there is said to be a *hidden fifth* in the

passage. The reader will, in the following example, see by the dots where these lie.



In a regular ascent, it is common for a fifth to be succeeded by a sixth, as in a descent it is common for the seventh to be succeeded by a sixth. Of both these, which are termed *sequences*, the following are examples:—





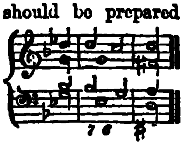
The extreme sharp fifth, which consists of two major thirds placed above each other, is generally considered and treated as a passing note, as in the following examples:—

It is here seen that the extreme sharp fifth to the bass, whether it be in the middle or at the top of the chord, always rises to the resolution. It is called a *transient chord*.

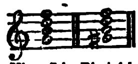
The sixth, by inversion, becomes a third; and it often happens that the bass which accompanies sixths will harmonise equally well with thirds. When accompanied with the fifth, the fifth is treated as a discord; this may be illustrated by two or three instances.

A species of this chord much used in minor keys consists of a perfect fifth, an extreme sharp sixth, and major third; and the bass of it generally descends,

The major seventh accompanied with a third major and perfect fifth is one of the most agreeable of the discords; the seventh should be prepared in the preceding chord



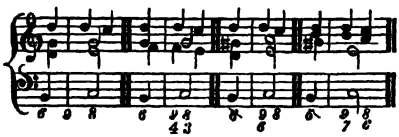
, and should be resolved by descending. If the major seventh is, however, accompanied by the second and fourth, it resolves upwards on the octave. By raising the lower note of a minor seventh a minor semitone, the chord of the diminished or extreme flat seventh is produced,

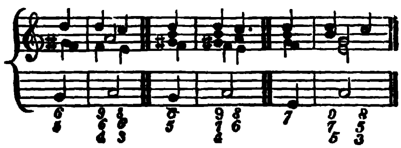


Minor 7th. Diminished 7th.

. This is also called the equivocal chord, from the uncertainty of the key into which it may lead.

The ninth major is a whole tone, and the minor ninth a semitone major above the octave. Both should be prepared in the preceding chord, and resolved by descent. When the ninth is used in four parts, the third and fifth must be taken with it. It must be accompanied at the resolution by an eighth, if the piece be in four parts. We subjoin a few examples:—





The ninth may have other discords mixed with it, as the fourth, in which case the fourth must be prepared and resolved as a discord. The seventh may be also mixed with it; in which case the seventh must be also separately prepared and resolved.

Modulation consists, as we have before stated, in passing from one key to another. The methods of accomplishing this are almost numberless, and we can therefore only refer to the explanations given in books of harmony, or, still better, to the examples to be found in the works of all eminent composers.

Counterpoint refers to the composition of music in several distinct and separate parts. We have before said that harmony implies that several sounds are heard at the same time; and the art of counterpoint consists in so arranging these several sounds that each of them may belong to a distinct part, capable of being performed throughout by a separate voice or instrument. Each of these parts must form a kind of melody of itself, and yet when heard together the combination of them all must be

so arranged as to produce satisfactory harmony. It is in vocal compositions that counterpoint is chiefly exhibited—glees, madrigals, and choruses being all examples of this kind of music; but it is also shown in instrumental compositions, particularly for the stringed band, as in quartetts and quintetts, and also to some extent in orchestral works, although in these all the parts are not *real*, i.e. not perfectly distinct from each other. The best organ compositions, as for example the works of Sebastian Bach, are all strictly contrapuntal, and may indeed generally be divided into perfectly distinct parts, though played on one instrument only. In pianoforte music, the counterpoint is less decided; but a good composer will, whatever be the kind of music, always exhibit his contrapuntal power.

The number of distinct parts used in counterpoint of course varies exceedingly. It cannot exist with less than two; but this number must necessarily give imperfect harmony. Three is a better number, but four parts is by far the most common, and indeed the most satisfactory, as this number enables the harmony to be made quite complete, while, by a skilful arrangement, the parts, not being numerous, will make themselves each perfectly distinct to the ear. Beyond this the difficulty of composition increases; but five, six, seven, and eight parts are quite common in the church compositions and in the madrigals of the older composers. Indeed, so skilful were the ancient writers in this art, that compositions of twelve, sixteen, twenty-four, forty-eight, and even as many as ninety-six real parts are in existence.

The style of counterpoint may also vary considerably, and five kinds are generally mentioned in books on the subject; namely, 1. Note against note. 2. Two notes in one part to each one in another. 3. Three or four notes to one. 4. Syncopations in one of the parts; and 5. Florid counterpoint. There are rules for writing in all these styles, and in various numbers of parts, for which, however, we must refer to the many excellent treatises on the subject.

The study and practice of counterpoint have been greatly neglected by composers and students of the present day—a circumstance much to be regretted, as the successful application of the art gives to music one of its greatest charms.

There are several special forms of contrapuntal musical composition, as canon, fugue, and imitation.

A *canon* is a composition in which several parts take up strictly the same subject or theme, but at different points of time, and usually on different parts of the scale. Sometimes in some of the parts the subject is inverted, or taken backwards, or augmented, or diminished. The well-known grace after meat, *Non nobis Domine*, is a fine specimen of a canon in three parts.

A *fugue* is something like a canon, inasmuch as the several parts repeat the same subject, but it is usually longer and less strict in style. Handel's choruses abound in fine fugues.

Imitation is even less strict. It is when the different parts merely imitate each other, without adhering strictly to the subject given. It is found in all sorts of music by good writers.

Rhythm is to music exactly what prosody is to poetry; namely, it relates to the division of the composition into parts of various lengths, so as to satisfy a natural desire for uniform motion and equable division of time. Thus the length and accentuation of each separate bar constitute a part of the rhythm of the whole piece; but in addition to this there are divisions of greater length, such as phrases, sections, and periods of two, four, or eight bars, which are necessary to give symmetry and perspicuity to the whole. Contrapuntal music, from its peculiar nature, is often without any rhythm, except the simple bar; but almost all music of a lighter or more modern kind is rhythmical; indeed, it must be so to be pleasing. The most perfect rhythm is found in dance music, in which the divisions into four and eight bars are very clear and intelligible.

Music Types. In Printing, the movable types used in producing cheap music in large quantities. The first really good music types were those cut by Mr. Hughes some five-and-twenty years since. Mr. E. Cowper invented a mode by which music could be printed in two forms, one being the lines, printed first, the other the notes, &c., printed upon it. This plan did not work well; and the late Mr. Branston devised a method of striking the punches deeper into the plate, and then taking a stereotype plate from it in type metal. After the white parts were blocked out, the music was sufficiently in relief to be capable of being printed at the common printing press. MS. music types, however, cast in good metal, best answer the purposes of the printer.

Musical Glasses. A musical instrument consisting of a number of glass goblets, resembling finger glasses, which are tuned by filling them more or less with water, and played upon with the end of a finger damped. There are few persons at a dinner table who have not tried their skill in producing the sound which the vibration of a finger glass will yield in the way above described. The less the quantity of water in glasses of similar forms and equal capacity, the lower will be the tone of the scale; hence the facility of forming a complete scale by the quantity of water contained in each.

The skill, or rather knack, of operating upon the sets of glasses for the production of melodies and harmonies, is that of procuring instantly the required vibration by a gentle and rapid action of the finger upon their edges, and so quickly from one to another as to be able to introduce harmonies to the sounds of the air or melody before the vibrations of its glasses have ceased. A touch of the finger on

the edge of a glass puts, of course, a stop to its vibration, and thus prevents confusion.

Musk. A peculiar concrete substance, the produce of the *Moschus moschiferus*, or musk deer, an animal which inhabits the mountains of Eastern Asia. Behind the navel is a bag, which in the adult animal is filled with musk. These bags are imported from China, Bengal, and Russia. Musk is originally a viscid fluid, but dries into a brown pulverulent substance, of a strong, peculiar, and highly diffusible odour. Its chief use is as a perfume: it has been employed in medicine as a stimulant antispasmodic, but much difference of opinion exists as to its efficacy; and its high price and extreme liability to adulteration are against its use.

Musk, Artificial. A substance obtained by the action of nitric acid upon oil of amber, and having an odour which some have thought to resemble that of musk.

Musk Deer. *Moschus moschiferus* (Linn.). The type of a distinct genus of Ruminants, with canine teeth and without horns. This species is especially remarkable for the large preputial glandular pouch which secretes the well-known substance called *musk*.

Musk Root. The Sambul root, supposed to be derived from a species of *Angelica*; also the Spikenard, *Nardostachys Jatamansi*.

Muskat. A rich sweet wine, made, in the South of France, of over-ripe muscadine grapes.

Musket. The firearm used by the regiments of the line. A great number of very curious muskets, of various dates and countries, from the earliest period of their use, may be seen in the repository of the Royal Artillery at Woolwich. 'When hawks were supplanted by firearms, the name of the birds of prey, formerly used in hawking, were transferred to the new weapons. *Mosquet*, the name of a sparrow-hawk, so called on account of its dappled (muscatus) plumage, became the name of the French *mousquet*, a musket. *Fauoon*, hawk, was the name given to a heavier sort of artillery. *Sacre* in French and *saker* in English mean both hawk and gun; and the Italian *terzemolo*, a small pistol, is closely connected with *terzuolo*, a hawk. The English expression, *to let fly at a thing*, suggests a similar explanation.' (Max Müller, *Lectures on Language*, second series, p. 229.) Mr. Wedgwood (*Dict. of English Etymology*, s.v. 'Musket') holds that *mosquet*, as the name of a hawk, was not taken from its speckled breast, but is to be identified with the Dutch *mossche*, *mussche*, a sparrow, a word preserved in the English *titmouse*. It appears, further, that the words, *mousquette* and *muschita* signified an arrow long before the invention of firearms. The archives of Bologna for 1381 contain an item, 'Ducentas septuaginta quatuor muschitas impennatas de cartâ in unâ cistâ,' and similar items occur in the archives of Lille for 1382. (Napoleon III. *Études sur l'Artillerie* i. 361.) This, however, only throws the metaphor one stage further back, the name of the hawk having been used to denote first an arrow and then a firearm. [Small-arms.]

Musketoon (Fr. mousqueton). A species of musket in use towards the close of the seventeenth century, shorter, but thicker and wider in the bore, than the ordinary musket. It had a flint lock.

Muslin. A fine thin kind of cotton cloth with a downy nap on the surface. The name is derived from the town of Mosul, in Asia, where it was originally manufactured. The first muslin was imported from India into England in 1670; and twenty years afterwards it was manufactured in considerable quantities both in France and England. Muslins are now manufactured in immense quantities at Manchester and Glasgow, in France, Germany, and Switzerland, rivalling those of India in fineness and durability, while they are also much cheaper. [Cotton.]

Musophaga. A genus of Scansorial birds, characterised by the base of the beak forming a disc which partly covers the forehead. The species of this genus are called *plantain eaters*, because their principal food is the fruit of the banana.

Mussel. [Mytilus.]

Mussite. A greyish-green variety of Diopside, from the Mussa Alpe in Piedmont.

Mussulman. A general appellation in European languages for all who embrace the faith of Mohammed. The term is derived from the Arabic *muslim*, a believer, and is said to have been first applied in Europe to the Saracens.

Must (Lat. mustum, Ger. most). The expressed juice of the grape before its conversion into wine by the process of fermentation. According to Berard the juice of ripe grapes contains sugar, gum, gluten, malic acid and malate of lime, bitartrate of potash and bitartrate of lime. The acidity of the juice of ripe grapes is principally due to the tartar which it contains, and which is precipitated by the alcohol formed during fermentation.

Mustard (Fr. moutarde, Venetian mostarda). The common name for *Sinapis*. The white mustard is *Sinapis alba*, and the black mustard *Sinapis nigra*. The seeds of the former are grown with those of cress to furnish what is known as small-salading; and together with those of the latter they furnish, when ground, the mustard of commerce. The mustard-tree of the New Testament is by some persons regarded as being the *S. nigra*, which in the climate of Palestine grows to a much larger size than with us; but by others it is considered to be a species of *Salvadora*.

The seed of the *Sinapis alba* and *nigra* forms, as already mentioned, when ground into powder and freed from the husks, the well-known condiment of the shops, or at least a part of it; for in order to reduce the strength of the pure mustard, a considerable quantity of wheaten flour is generally added. Brown mustard should be the flour of *Sinapis nigra* exclusively, which

is much more pungent than the other. A dessert-spoonful of coarsely powdered mustard seed, taken in a glass of water, generally operates as an emetic; it is also aperient. A mustard poultice, or *sinapism*, is sometimes a useful stimulant.

Mustard, Oil of. Mustard contains a fixed oil composed of erucin and olein, and also yields, when moistened with water, a volatile oil which is the sulphocyanide of allyl. The latter is the source of the pungent flavour and odour characteristic of recently made mustard paste. It is produced by the action of a ferment, *myrosin*, upon *myronic acid*, in the presence of water, and does not therefore pre-exist in the mustard seed, but is first formed when the crushed seed is macerated with water.

Mustela (Lat. *a weasel*). The generic name under which Linnæus comprehended the Vermine or Vermiform quadrupeds of Ray, or the carnivorous Mammalia, which are distinguished by the length and slenderness of their bodies, and are thus enabled to wind, like worms, into very small crevices and openings, whither they easily follow the little animals that serve them for food. The otters, skunks, polecats, and weasels were included in this genus, and still constitute the natural family *Mustelidæ*; but the genus *Mustela* is now restricted to the true weasels, which differ from the polecats in having an additional false molar above and below, and in the existence of a small internal tubercle on the lower *carnassial* or sectorial tooth; two characters which, Cuvier observes, somewhat diminish the cruelty of their nature.

Muster. On Shipboard, a weekly calling over of the men, each of whom passes across the quarter-deck as his name is called. It takes place also after a battle in order to ascertain the casualties.

Muster-roll (Old Fr. monstrer, *to show* or *review*). A specific list of the officers and men in every troop, battery, or company, accounting for every individual. At *muster*, which takes place on the last day of every month, every name on this list is called, and any officer absent without leave is not entitled to pay for the following month. A soldier so absent is not entitled to pay for that day, and is liable to imprisonment.

Mute (Lat. mutus). A dumb officer of the seraglio, whose duty it is to act as executioner of persons of exalted rank who have incurred the sultan's displeasure. The term *mute* is also applied to persons employed by undertakers to stand before the door of a house in which there is a corpse, for a short time before the funeral.

MUTE. In Grammar, a vowel (or consonant) is said to be mute when written but not pronounced; as the vowel *e* at the end of many English words, in some of which it effects a change in the pronunciation of the preceding vowel, as in *wife*, *life*, *place*, &c., rendering it long; after a diphthong it has no effect, as in *house*. In old English, the *e*, now mute in many words, especially in nouns, retained its inflexional character and had a syllabic power, as in the poetry of Chaucer, &c.

MUTE. In Law, this term is applied to a person who refuses to plead to an indictment for felony, &c. By stat. 12 Geo. III. c. 20 such a person is to be considered as pleading guilty, but by 7 & 8 Geo. IV. c. 28 the court may order a plea of *not guilty* to be entered for him. Formerly a plea was extorted from him by the inhuman process of PEINE FORTE ET DURE [which see].

Mutica (Lat. muticus, *maimed*). A name applied by Linnæus to the third of his primary divisions of Mammalia, including the whale tribe, as being maimed, or deprived of the hinder pair of extremities; also given by Storr to an order of quadrupeds comprehending those which want either a certain kind of teeth, or are wholly edentulous.

Mutilata (Lat. *mutilated*). This division of Gyrencephalate Mammalia is so called because their hind limbs seem, as it were, to have been amputated: they possess only the pectoral pair of limbs, and these in the form of fins; the hind end of the trunk expands into a broad horizontally flattened caudal fin. They have large brains with many and deep convolutions, are naked, and have neither neck, scrotum, nor external ears. It is composed of the two orders *Cetacea* and *Sirenia*.

Mutiny (Fr. mutin, *rebellious*). In Law, the offence, in a person under military or naval authority, of resisting or refusing obedience to that authority. The Mutiny Act is a statute annually passed since the reign of William and Mary (April 1689), by which the crown is vested with power to form articles of war, and to constitute military courts martial. [COURTS MARTIAL.]

Mutule. [MODILLION.]

Muzarabs, Mozarabes or **Mostarabes.** Christians living under the government of the Moors in Spain; so called, it is said, from an Arabic word signifying adoptive Arabs (adscititii). The denomination is now chiefly remembered in consequence of the celebrated disputes between the supporters of the Muzarabic liturgy, which was preserved by the Christians of Spain during their subjection to the Mohammedans, and those of the Roman, introduced by the see of Rome about the tenth century. During the following age this dispute was warmly carried on, and well-known legendary tales of miracles wrought in favour of the ancient ritual were long current in Spain. It was, however, gradually superseded by the Catholic. It is said that mass is still celebrated according to the Muzarabic ritual in one chapel at Toledo. (Gibbon, *Roman Empire*, ch. li.)

Muzzle (Fr. museau, Ital. muso). In Artillery, the part of a gun next the mouth. [GUN.] In the smooth-bored cast guns, the thickness of metal is increased at the muzzle, forming what is called the *tulip* or swell of the muzzle.

——s. The lashing by which the muzzle of a gun in a ship is secured to the upper part of the port, to prevent motion during rough weather.

Mya. A name applied by Linnæus to a genus of the *Vermes Testacea*, including those having a bivalve shell, characterised by a hinge with broad, thick, and strong teeth, seldom more than one, and not inserted into the opposite valve; shell generally gaping at one end. The Molluscs thus characterised form the first family (*Myacidæ*) of the section *Siphonida* among the conchiferous Mollusca. They have been subdivided into the genera *Mya, Corbula, Sphenia, Neæra, Thetis, Saxicava, Glycimeris, Panopæa.*

Mycelia (Gr. μύκης, *a fungus*). The young flocculent filaments of fungi.

Mydriasis. Preternatural dilatation of the pupil of the eye.

Myelencephala (Gr. μυελός, *marrow*, and ἐγκέφαλος, *brain*). The name indicative of the condition of the nervous system of the primary division of animals, comprehending those which have a brain and spinal chord: it is synonymous with *Vertebrata.*

Myelin. A yellowish or reddish variety of Kaolin from Rochlitz in Saxony.

Myelon (Gr. μυελός, *marrow*). The single-worded equivalent of *spinal marrow* and *spinal cord.*

Myeloneura (Gr. μυελός, and νεῦρον, *nerve*). A name given by Rudolphi to a group of animals corresponding to the Articulata of Cuvier, viz. Crustacea, Insects, and Anellides, which have a gangliated nervous system, forming a chord considered to be analogous to the spinal marrow of Vertebrates.

Mykomelinic Acid. An acid resulting from the mutual action of alloxan and ammonia. [URINE.]

Mylo. Names compounded of this word are applied to certain muscles attached near the grinder teeth, as *mylohyoideus, mylopharyngeus,* &c. [MOLARS.]

Mylodon (Gr. μυλόδους, *a grinder tooth*). A genus of *Megatheriidæ*, which was discovered by Mr. Charles Darwin, at Punta Alta, near Bahia Blanca, in Northern Patagonia. The entire skeleton, which is now in the College of Surgeons, affords a proof of the existence of an animal not so large nor so powerfully built as the gigantic *Megatherium*, but teleologically adapted like that species for the uprootal, by energetic vibration, of the trees on the tender succulent leaves of which it depended for sustenance.

Myocommata (Gr. μυελός, and κόμμα, *a section*). The lateral flakes into which the muscular system of fishes is divided. Each is attached by its inner borders to the osseous and aponeurotic parts of the corresponding vertically extended segment of the endoskeleton, by its outer borders to the skin, and by its fore and hind surfaces to an aponeurotic septum, common to it and the contiguous myocommata.

Myology (Gr. μύων, *a muscle*, and λόγος). The doctrine of the muscles. In the Fine Arts, the term is applied to a description of the muscles of animals.

Myoporaceæ (Myoporum, one of the genera). One of the orders of perigynous Exogens included in the Echial alliance, and distinguished by the irregular unsymmetrical flowers, confluent nuts, pendulous ovules, and two-celled anthers. The Avicennias which belong to this group are shore trees, living like Mangroves in salt swamps.

Myops (Gr. μύωψ, *blinking*). A person who is purblind or near-sighted. This defect usually arises from too great convexity of the cornea causing the rays to come to a focus before they arrive at the retina. It is corrected by the use of glasses which increase the divergency of the rays before they enter the cornea, and thereby throw their focus farther back, so as to fall on the retina.

Myriad (Gr. μυριάς). Ten thousand. The word is often used as expressive of an indefinite multitude.

Myrialitre. A French measure of capacity equal to ten thousand litres, or 610,280 cubic inches.

Myriamètre. A French measure equal to ten thousand mètres; it is the equivalent of two leagues of the old measure. [MEASURES.]

Myriapods (Gr. μυριάς, *myriad*, and πούς, *foot*). The name of a class of Articulate animals, including those which have an indeterminate number of jointed feet, equalling that of the articulations of the body.

Myrica (Lat.; Gr. μυρίκη). The typical genus of the *Myricaceæ*, consisting of small shrubs or small trees, one of which, *M. Gale*, is a native of bogs in this country, and is called Sweet Gale or Bog Myrtle on account of its fragrant leaves. The pleasant acid fruit of *M. sapida*, which is about as large as a cherry, is eaten in Nepal. The most important, however, is the wax-bearing *M. cerifera*, the fruits of which are coated over with a thickish waxy secretion.

Myricaceæ (Myrica, one of the genera). A small order of diclinous Exogens of the Amental alliance, distinguished by their one-celled ovary and single erect seed with a superior radicle. The order comprises only *Myrica* and one or two other small genera.

Myricin. That portion of wax which is insoluble in alcohol. It melts at 147° Fahr. The wax of the *Myrica cerifera* affords it.

Myricylic Alcohol. The hydrated oxide of myricyl. The oxide of myricyl exists in bees-wax in combination with palmitic acid, and is liberated in the hydrated form by the action of caustic potash. Myricylic alcohol is a colourless solid, of a silky lustre, melting at 185° Fahr.

Myriorama (Gr. μυριάς, *a myriad*, and ὁράω, *I view*). A picture made up of fragments of buildings, landscapes, &c., so as to admit of an infinity of combinations.

Myristic Acid (Gr. μύρον, *unguent*). One of the fatty acids contained in the expressed oil of nutmeg.

Myristica (Gr. μυριστικός, *fit for anointing*). The genus of *Myristicaceæ* which yields the Nutmeg. This fruit is the produce of *M. moschata*, or *officinalis*, a tree of the Molucca Isles, Java, &c. growing twenty feet or more in height, bearing elliptic leaves, and axillary clusters of flowers. The fruit, which resembles a peach, bursts into two pieces, by which the enclosed seed covered by its arillode or false aril (Mace) is exposed. The seed has a hard outer shell, which is removed when dry, the albuminous interior mass forming the Nutmeg of the shops. The most esteemed are those of Penang. *M. fatua, Otoba, tomentosa, acuminata*, and others, especially the first, yield nutmegs which find their way into the market from Brazil, the Philippine Islands, and Madagascar.

Myristicaceæ (Myristica, one of the genera). A natural order of arborescent Exogens inhabiting the tropics and belonging to the Menispermal alliance of diclinous Exogens, in which they are known by their valvate cup-shaped calyx, and their ruminated albumen. ... it has been sometimes placed in *Lauraceæ*, from which it is distinguished by the structure of the calyx, anthers, and fruit. Brown places it between *Proteaceæ* and *Lauraceæ*; and it has also been regarded as an apetalous form of *Anonaceæ*, agreeing in the trimerous flowers, arillate seed, ruminated albumen and minute embryo. The bark generally abounds in an acrid juice, which is viscid and stains red. The rind of the fruit is caustic; the aril and albumen of *Myristica moschata*, the former known under the name of *Mace* and the latter of *Nutmeg*, are important aromatics abounding in a fixed oil of a consistence analogous to fat, which, in a species called *Virola sebifera*, is so copious as to be extracted easily by immersing the seeds in hot water.

Myristin. Myristate of glyceryl, from nutmeg-butter.

Myrmecobius (Gr. μύρμηξ, *ant*; βίος, *life*). A genus of Marsupial quadrupeds which feed ... The only known species, *Myrmecobius fasciatus*, is a native of Australia.

Myrmecophaga (Gr. μύρμηξ, and φάγω, *I eat*). The name of a genus of Edentate quadrupeds which feed on ants, and are called *ant-eaters*. They are peculiar to the continent of South America.

Myrmeleonidae (Gr. μύρμηξ, and λέων, *lion*). The family of insects commonly called *ant-lions*, having the genus *Myrmeleon* as the type.

Myrmidons (Gr. Μυρμιδόνες). The followers whom Achilles led from Phthia to the Trojan war. The name (like that of Achilles, Helen, Paris, and many others) cannot be explained by any Greek words. According to one version of the myth, Zeus deceived Eurymedusa, daughter of Cleitus, in the form of an ant (μύρμηξ), and became the father of Myrmidon, the eponym of the Myrmidones. The Homeric poems exhibit the Myrmidons as warriors who cannot act except at the bidding of Achilleus. Where he appears, they rush forth like wolves, λύκοι ὣς (*Il.* xvi. 156). The simile which follows lays special stress on the fiery colour of their cheeks, and the blood-red hue of their tongues and jaws. These images are in strict accordance with the solar character of Achilles [MYTHOLOGY], and the expression λύκοι thus at once suggests a comparison with the myths of LYCAON, Callisto and Arcas, and with the epithet Lycius (λύκιος) applied to Phœbus (Æschylus, *Theb.* 145). The Myrmidons would thus be the streaming rays which break forth when the sun reappears after being veiled by clouds. [EPIC; ILIAD.]

Myrobalan (Gr. μυροβάλανος, because formerly used in the preparation of unguents). A bitterish austere fruit, brought from India. Belleric Myrobalans are the fruit of *Terminalia Bellerica*, Chebulic of *T. Chebula*, Indian of *T. citrina*. Myrobalans are used by the Hindus in calico printing and medicine. The fruits of *Emblica officinalis* are sometimes called Emblic Myrobalans.

Myronic Acid. One of the components of black mustard seed.

Myrosin. [MUSTARD, OIL OF.]

Myrospermum (Gr. μύρον, and σπέρμα, *seed*). To this genus of *Leguminosæ* belong the plants yielding the Balsams of Peru and of Tolu. The first is the produce of *M. peruiferum*, and is obtained by making incisions in the bark, thrusting cotton rags into the wound, and lighting a fire round the tree to liquefy the balsam. The rags are afterwards boiled, and the balsam collects below. It has a fragrant aromatic smell and taste, and has been used in chronic coughs, &c. The second is similar in character, and is derived from *M. toluiferum*. They are tropical American trees, with unequally pinnate leaves, and axillary racemes of white or rose-coloured flowers.

Myroxylic Acid (Gr. μύρον, and ὀξύς, *sharp*). A substance obtained from the Peruvian balsam, the produce of the *Myrospermum peruiferum*, formerly called *Myroxylon*.

Myrrh (Lat. myrrha, Gr. μύῤῥα). This gum resin is imported from Turkey. It is produced by *Balsamodendron Myrrha* in irregular tears and lumps, of a reddish brown colour, a fragrant odour, and a warm but bitter taste. It is a good stimulating tonic medicine, and is given in doses of from five to twenty grains.

Myrrhic Acid. A substance obtained by heating the resin of myrrh.

Myrsinaceæ (Myrsine, one of the genera). A natural order of perigynous Exogens, referred by Lindley to his Cortusal alliance. In this group they are known by their woody stems, by having stamens opposite the petals and by their indehiscent drupaceous fruit.

They occur chiefly in islands of equable temperature, as those of the Indian Ocean, Mauritius, Bourbon, and Madagascar. Many of them are ornamental, but little is known of their properties. Bread is said to be made from the pounded seeds of *Theophrasta Jussiæi* in St. Domingo.

Myrtaceæ (Myrtus, one of the genera). An important natural order of polypetalous Exogenous plants of a woody texture, frequently forming small trees, and found in all tropical and temperate countries, where they are often cultivated for the sake of their valuable aromatic properties. They belong to the Myrtal alliance of epigynous Exogens; and their most essential characters are to have polypetalous calycifloral flowers, indefinite stamens, round erect anthers, inferior fruit, and dotted leaves with an intra-marginal vein. The spices *Cloves* and *Pimento* are produced by *Caryophyllus aromaticus* and *Eugenia Pimenta*; the agreeable fruits called *Guava, Jamrosade,* and *Roseapples* are yielded by *Psidium Guava, Eugenia malaccensis*, &c.; while the enormous *Gum-trees*, or *Eucalypti*, of New Holland, and the *Melaleuca*, which furnishes the oil of *cajeput*, also belong to the order. *Myrtaceæ* are nearly related to the Onagraceous order, from which they differ in having an indefinite number of stamens; and to *Melastomaceæ*, which have rostrate inflected anthers and ribbed leaves.

Myrtle. [MYRTUS.]

Myrtus (Lat.; Gr. μύρτος). The typical genus of the order *Myrtaceæ*, and best known by the Common Myrtle, *M. communis*, a shrub with fragrant shining evergreen leaves and white flowers. Amongst the ancients the Myrtle was held sacred to Venus. The wood is very hard, and beautifully mottled.

Mysorine. An anhydrous carbonate of copper found at Mysore in India.

Mystacineæ (Gr. μύσταξ, the *upper lip* or *moustache*). The name of a family of Infusories of the tribe *Trichoda*, including those which [illegible] cilia, or fine hair-like processes, [illegible] Many species of animals derive their trivial name from the same root, as the *Vespertilio mystacinus*, or whiskered bat; the *Caprimulgus mysticalis*, or bearded goat-sucker; the *Cypselus mystaceus*, or bearded swift, &c.

Mysteries (Gr. μύω, *to be closed or shut*, hence μυέω, *to initiate in mysteries*, μύστης, *one so initiated*, and μυστήριον). The desire to shroud certain doctrines or ceremonies in an obscurity penetrable only by those who have undergone a systematic initiation seems to have been common to most ancient nations. Thus, we find such mysteries or orgies existing in Egypt, Asia Minor, Greece, &c.; and it has been thought that in the latter they were directly derived from the former. But if there is little doubt that the Greek mysteries were greatly modified by the influence of Egyptian sacerdotalism, the existence of mysteries in Greece before any such influence could have been exercised seems scarcely less clear. Beyond this, the subject is involved in great uncertainty, and it might be rash to do more than state the opinions, sometimes conflicting, which have been entertained by historical critics with regard to the origin and character of these mysteries. The idea that from beginning to end they were an imposition for the mere purpose of extending the authority of priests, may perhaps be dismissed at once. As in the case of the oracles, the mysteries could never with such a foundation have held their ground, while it is also certain that the initiated were not only not all priests, but numbered among their ranks some of the wisest thinkers and the greatest statesmen. In Greece, and especially at Eleusis, the rites had apparently a local significance, and were directly referred to distinctively Pelasgic gods; hence some historians have connected the mysteries with the primitive religion of Greece, before the introduction of the frenzied rites of Egypt, Asia Minor, and Thrace. Thus Bishop Thirlwall regards them as 'the remains of a worship which preceded the rise of the Hellenic mythology and its attendant rites, grounded on a view of nature, less fanciful, more earnest, and better fitted to awaken both philosophical thought and religious feeling.' At the same time he thinks it 'extremely doubtful how far they were ever used for the exposition of theological doctrines differing from the popular creed.' (*History of Greece*, ch. xii.) In the same way, from the manner in which they were all confused in the minds of various authors, Mr. Grote (*History of Greece*, part i. ch. i.) infers a close correspondence in character between the rites of the Idæan Zeus in Crete, of Dêmêtêr at Eleusis, of the Cabeiri in Samothrace, and Dionysus (Bacchus) at Delphi and Thebes. These rites were in his opinion originally devoid of the element of mysticism or secrecy which, 'if not originally derived from Egypt, at least received from thence its greatest stimulus:' but he adds that this change altered also the original idea, and that the secrets which they now professed to teach would 'be such as to justify by their tenor the interdict on public divulgation,' and he concludes that it has never been shown, and is to the last degree improbable, 'that any recondite doctrine, religious or philosophical, was attached to the mysteries, or contained in the holy stories,' whether of the Egyptian priests or any others. On the other hand, Dean Milman (*History of Christianity*, vol. i. ch. i.) attributes to them a Pantheistic doctrine, and a morality springing from the ancient Nature-worship of the East. But that the character of these mysteries was essentially dramatic, is beyond question. (Grote, *History of Greece*, part ii. ch. xliii. vol. v. 282, note.) This fact is clearly proved by the concluding ceremonies of the greater Eleusinian mysteries (apart from anything which may have preceded them), when the initiated, returning to Athens, sat down to rest on the roadside, and assailed all passers-

by on the bridge of the Cephisus with coarse ribaldry and ridicule. This jesting and scoffing, according to the local explanation, merely represented the rude playfulness of the servant-maid Iambê, who (in the Homeric hymn to Dêmêtêr) is said to have distracted the grief of the sorrowing goddess. (Grote's *History of Greece*, vol. i. p. 56 &c.)

Of the Egyptian mysteries, and the alleged marvels which they revealed to the initiated, little can be said with certainty. Probably 'their ceremonies were at once more licentious and more profane in the outpouring both of joy and sorrow than the Greek;' and an intricate yet thoroughly organised priestly system brought the dramatic character of their mysteries to bear with greater power on the minds of the worshippers. The symbolical instruction, which is said to have been given in these mysteries, forms the groundwork of some chapters in Moore's *Tale of the Epicurean*. (For a further account of them, see *Cabinet Cyclopædia*, vol. lxi.; Sir G. Wilkinson's *Ancient Egyptians*, vol. ii. second series.)

It is, however, urged by some, that the opinions already noticed afford only a partial explanation of the phenomena of the mysteries; that religious celebrations accompanied by rites which are in varying measure common to Greece, Egypt, Syria, Phœnicia, Hindustan, and other countries, cannot be explained by reference to local customs, legends, or myths of any one of those countries; that no theory can be accepted as satisfactory which fails to throw light on the scattered and broken evidences which seem to indicate a common origin for all; that this common origin seems to be the worship of the vivifying principle, as exhibited in the procreative powers of living beings, and symbolised in the rites of Adonis, Aphrodite, Isis, Thammuz, Dêmêtêr, and other deities. That the LINGA from time immemorial has been a chief symbol of Hindu worship, is, it is maintained, as little to be questioned as that the adoration of the PHALLUS entered largely into that of the Greeks. The corresponding emblem to the Linga was the YONI, or symbol of the earth, as the mother of living things; and this symbol, under its name Argha, signifying a cup or vessel, gave rise, it is affirmed, to the myth of the ship Argo (signum in modum liburnæ figuratum: Tacitus, *Germ.* 9), Iswarra (Dionysus) being styled Argha-Nautha, or lord of the boat-shaped vessel. The authority of Theodoret, Arnobius, and Clement of Alexandria is claimed for the assertion that the Yoni of the Hindus was an object of veneration in the Eleusinian mysteries; and it is asserted that the purification of women in these mysteries (as exhibited in vases in the Hamiltonian collection at the British Museum), answered closely to that of the Sacti in the mysteries of the Hindus.

The whole subject requires obviously the greatest caution, and the most rigorous scrutiny of facts and evidence; but as the enquiry is still in a very early stage, it would be premature to add any further remarks to the foregoing sketch of the several opinions entertained by recent writers.

Mysteries. In Modern Literature, a species of dramatic composition, with characters and events drawn from sacred history. The mysteries of the middle ages are thought by some to have been first introduced by pilgrims returning from the Holy Land. They originated among, and were probably first performed by, ecclesiastics. However serious and solemn the events which were represented in these singular compositions, there were invariably, in the later mysteries, two characters introduced to make sport for the multitude: namely, the Devil and the Vice—a personage accoutred in a long jerkin, a cap with ass's ears, and a dagger of lath. He is now best remembered by the allusions to his character and office in the plays of Shakspeare. Miracles, or miracle-plays, were a species of mystery: they are usually said to have represented the martyrdoms of saints. In the sixteenth century, the mysteries were succeeded by *moralities*, which were much in vogue about the time when the Reformation made its chief progress in England. The characters in moralities were allegorical personages. Several of these performances, some by no means destitute of poetical merit, remain to us. They may be considered as the last step in the progress made by the dramatic art in modern Europe, before it reached the station and character which it has ever since retained.

The first biblical play on record is on Moses, and was the work of a Jew named Ezekiel in the second century; the second is a Greek tragedy on the Passion by Gregory Nazianzen. Religious plays were at an early time introduced into convents, and eagerly welcomed as breaking the monotony of convent life. A German abbess named Hroswitha composed some dramas of this kind in the tenth century. A great Passion-play is still celebrated every tenth year at the little village of Oberammergau in Bavaria; and such representations may be seen more frequently in the Basque country. (Lecky, *History of Rationalism*, vol. ii. ch. vi.; Francesque Michel, *Le Pays Basque*; *Edinburgh Review*, April 1864, p. 378 &c.)

Mysticism. In Religion, a word of very vague signification, applied, for the most part, indiscriminately to all those views or tendencies in religion which aspire towards a more direct communication between man and God (not through the medium of the senses, but through the inward perception of the mind) than that which may be obtained through revelation. Thus, the Pantheism of the ancient philosophers and many modern religionists, which supposed a God existing in all space and matter, and revealed to us in the outward manifestations of things; the Quietism of Madame Guyon, Fénelon, &c., who sought for direct revelation from the Divinity to the believer in a species of ecstasy; the Pietism of Molinos; the doctrines of the Illuminati in Germany; the visions of Swedenborg; and some of the notions

prevalent among the Methodists and other sects among ourselves—all approximate to mysticism.

Mythology (Gr. μυθολογία). By this term is generally understood the body of legends or traditions handed down by a people respecting their gods, heroes, and preternatural beings. It has been ascertained that the mythology of all the Aryan nations has a common source and groundwork: and that this groundwork was the ordinary speech of the people before the dispersion of the race. This language, as is evident from the Vedic Hymns, &c., attached a living force to all natural objects; and when its original meaning had been half forgotten by the several branches of the race in their new homes, its expressions still remained in the description of personal and anthropomorphous gods. Every word became an attribute, and all ideas, once grouped around a single object, branched off into distinct personifications. Thus the sun had been the lord of light, the driver of the chariot of the day; he had toiled and laboured for men, and sunk down to rest after hard battle in the evening. From such phrases sprang Phœbus and Apollo; and while Helios remained enthroned in the sun, his toils and death-struggles were transferred to Heracles (Hercules). Thus Endymion, a word meaning nothing more than the setting sun, became a youth who slept in the cave of Latmos (or forgetfulness). [LETHE and LATONA.] Hence the mythology of the Greeks, Romans, &c., becomes strictly a part of comparative philology, and can only be explained by it.

MYTHOLOGY, COMPARATIVE. As long as any people are acquainted only with their own legends and their own language, it is as impossible for them to analyse these tales to any good purpose as it was for Cæsar to know that the Gauls whom he subdued spoke a language akin to his own. The Greek could not of course fail to see the meaning of many names in his mythology. He could not but know that such names as Telephassa, Eurycleia, Eurygeneia, Iolê, Phaethon, were words which signified light, far-shooting and wide-spreading: but there were many others of which he could make nothing. He had received the exquisite legend of HERMES [which see]; but he had not the clue to guide him to the origin of the name: and he was wholly unable to explain such names as Achilleus, Paris, Helen, Procris, Ixion, by any words belonging to his own language. Hence he was driven to conjecture; and each false guess became probably the germ of a new version of the myth, while it removed the tale farther from its original condition of mythical speech into the concrete form of an anthropomorphous and not unfrequently repulsive and immoral legend. Of these tales each country and almost every city retained its own version, without any consciousness that they were for the most part only different forms of the same story. Thus the citizen of Argos took pride in the myths which clustered round the name of Perseus; while the men of Athens, Calydon, and Thebes had their tales of Theseus, Œdipus, and Meleagros. Yet the deeds attributed to them resembled each other in a way which nothing but the difference of names could have hidden from their eyes. Perseus is the destroyer, and he is the slayer of Medusa and the Libyan monster; but Apollo, also the destroyer, slays the serpent Python, and Bellerophon is the slayer of Belleros. Perseus goes to the land of the Graiæ and the Gorgons against his will; but against his will Heracles also toiled for Eurystheus, and Apollo served as a bondman in the house of Admetus. Theseus also is a destroyer. He slays the Minotaur, and destroys the mighty robbers who desolated the land. Perseus again is the child of Danaê, and the golden shower; but Phœbus is born in Lykia, the land of light. [LYCAON.] All these heroes, again, move from east to west, Perseus to the home of the Gorgons, Heracles to the land of the Hesperides, Kephalos from Hymettus to the Leucadian cape. They are all armed with invincible weapons: Apollo Chysaor bears his sword; Artemis the spear which slays Procris; Bellerophon, Heracles, and Achilleus the arrows which no enemy may withstand. All labour for the good of men, and the life of all closes in darkness, and generally with disaster. Perseus slays Acrisios, Œdipus kills Laios, Kephalos destroys Procris; and all do these deeds unwittingly. These parallelisms may be indefinitely extended. Œdipus, Paris, Perseus, Telephos, are all immediately after their birth cast forth to die: all are preserved in the same way with Cyrus, Romulus, and Chandragupta. If Theseus abandons Ariadnê, Paris forsakes Œnonê, while Deianeira and Coronis are deserted by Heracles and Apollo. The imagery which runs through the legends is the same. A spotless white bull bears Europa across the sea: a golden ram carries away the children of Nephelê, the cloud. Hermes steals the herds of Phœbus, the lord of light; while Phaëthusa and Lampetië, the bright and glistering, lead the cattle of Helios, the sun, to their pastures. But while to the Greeks all these were different personages, their legends exhibit many points of contact: and thus the epos of Argos, for example, is twisted into a complicated chain with that of Attica. All this by itself is remarkable enough; but the wonder becomes much greater when we find stories substantially the same recurring in the mythology of Northern Europe. The Norse heroes are likewise destroyers of dragons that lie coiled round sleeping maidens, and Sifrit and Sigurdr toil and fight for others not less than Heracles, Perseus, Achilleus, or Bellerophon. If Heracles sees Iolê again at the end of his career, if Briseis is restored to Achilleus, and Œnonê to Paris, so Brenhyldr comes before Sigurdr in the hour of his death. Like Achilleus, the Norse Baldr and the Persian Isfendiyar can be wounded only in a single spot. The life of Meleagros

cannot be cut short until the torch kindled at his birth has been extinguished: and, like the Jewish Samson, Nisos cannot be overcome as long as the mystic locks of hair remain unshorn. The tale of Perseus is repeated in that of his descendant Heracles, but so is that of Sigurdr in the legend of Ragnar Lodbrog. Thus the Hellenic and the Norse tales have each their own significance; but they all point in the same direction. It is the same story of the struggling and toiling sun, producing fruits for the children of men, conquering his enemies but conquered himself by an inexorable fate. Procris, in the Athenian legend, is the child of Hersê the dew, Eos is still the morning, Selênê is still the moon, Endymion is the son of Aëthlios the toiler, Phaethon is still the brilliant child of Helios, the sun. Judging, then, from the evidence before us, we should be led to infer that where the Greek spoke of Perseus, the slayer of Medusa, as being the child of Danaê, the ancestors of the Greek had spoken of the sun, the destroyer of night, as the child of the golden dawn; that when the Homeric poets spoke of the death of Achilleus and Meleagros, their fathers had spoken of the brief but magnificent career of the short-lived sun. It is clear, therefore, that if adequate evidence for such a form of speech could be found, it would furnish the key to the mythology not only of the Greek, but of the Teuton, the Scandinavian, and the Persian. Under the head of LANGUAGE it has been shown that the discovery of Sanscrit rendered a science of comparative philology not only possible, but certain. The same discovery supplied the mythological key which had been so long sought in vain. This key is furnished by the earlier Vedic hymns. (Max Müller, *History of Sanskrit Literature.*) In these hymns, Kephalos, Procris, Hermes, Daphnê, stand forth as simple names for the sun, the dew, the wind, and the dawn, each recognised as such, yet each endowed with the most perfect consciousness. In these hymns, when the night comes, the people say, 'Our friend the sun is dead: will he rise? will the dawn come back again?' and thus we see at once the death of Heracles or Kephalos, and the weary waiting while Leto struggles with the birth of Phœbus. When the day comes back, the cry, 'Rise! our life, our spirit is come back,' carries us at once to the Homeric hymn and the joyous shout of all the gods when Phœbus springs to life and light in Delos. In these early songs, the dawn is a maiden loved by Indra, from whose pursuit she flies, as Daphne fled from Apollo, and the tale of Orpheus and Eurydike appears in its earlier dress as the legend of Urvasî and Purûravas. The morning with its early breeze exhibits the germ of the tale of Hermes, and betrays the first sign of the faithlessness of Helen. [PARIS.] At once, names which in Greek mythology had defied all analysis become transparently clear. The Kentaurs or CENTAURS are the Sanscrit Gandharvas, the bright clouds in whose arms the sun reposes as he journeys through the sky. Ixion, the lawless lover of Hêra, is identified with the Sanscrit Akshivân, the being who turns on a wheel, the four-spoked cross seen in the heavens at noontide.

But it is obvious that language which might be both innocent and beautiful when applied to the sights and sounds of the natural world, might assume incongruous, repulsive, or disgusting phases, when these sights and sounds are anthropomorphised. Thus Œdipus like Perseus slays his grandsire, and as Heracles is in the end reunited to Iolê, is afterwards solaced with the love of Iocastê (Jocasta). But Iocastê is his mother: and the application of Greek ethical sentiment converted the legend into an appalling tale of incest, disaster, and ruin, until in the end Antigonê comforts him in his dying hour, as Iolê, Briseis, and Œnonê stand at last by the side of those who had loved them and forsaken them. Of such legends the *Iliad* and the *Odyssey* present only varying forms; how closely these forms resemble each other, can be determined only by an analysis of those poems, for which we have here no space; but such an examination seems to warrant the conclusion that not only in the chief incidents of the story, but in the personal characteristics of Achilleus and Odysseus, of Paris and Helen, of Phaethon and Telemachos, the Homeric poets worked on materials which came to them as a heritage from times long since passed away. They might embellish the materials, but they could not, and assuredly they have not, in each case, departed from the type set before them. It would follow, then, that the characters which they portrayed are not in strictness of speech national, or indeed even human. We have nothing to warrant the conclusion that the fierce wrath of Achilleus and Odysseus was ever exhibited by Achaian chieftains; and if we attempt to explain the tale by a reference to national character, we find ourselves utterly unable to explain why they fix on the methods which they choose for accomplishing their vengeance and winning their victory; why, for instance, Achilleus, like Meleagros, should choose inaction as the mode of avenging himself, and why he should make a vow not to rest until the blood of human victims should flow on the funeral pile of Patroclos, or why, again, Penelopê should weave and unweave her web [HYPERBOREANS], and why she should refuse to see her husband until the evening, and then test him by bringing before him the beautiful tapestry which he had woven for her long ago. [RISHIS, THE SEVEN.]

Thus, then, in India and Greece, in Norway, Germany, Scandinavia, and Persia, we have a mythical system which is essentially the same; in which the most striking names and incidents, the most remarkable details and imagery, are repeated with wonderful closeness. We find this parallelism in the legends of races who have certainly had no communication with each other since they assumed the form of distinct

nations, and who in all other respects exhibit very few (if any) common characteristics; and if we find that their most complicated epic poems disclose the same framework which is seen even in the most fragmentary legends, if we find that the adventures or the inaction of their heroes are simply the result of an inevitable process going on in all kindred languages, then all charges of immorality founded on the character of these adventures fall at once to the ground. It is simply impossible that such poets as Æschylus and Sophocles were descended from a people who, some centuries before, had deliberately sat down to invent ridiculous or loathsome fictions about the gods and heroes whom they worshipped and revered. In the Vedic mythology, Prajâpati, the lord of creation, did violence to his own daughter; but Kumârila was ready with an explanation which the science of comparative mythology has established as incontestable. (Max Müller's *History of Sanskrit Literature*, p. 530.) The legend of Erichthonios, the coarsest perhaps in the whole range of Greek mythology (Apollodorus viii. 1. 46), resolves itself into a few mythical phrases as beautiful as they are innocent and pure; and all mystery therefore is removed from that strange combination of repulsive legends with a sensitive morality which is exhibited in the Hesiodic poem of the Works and Days. These legends lay bare to us, in fact, the workings of the human mind from a time indefinitely transcending all historical memorials whatsoever; and so clear is the light thus thrown on the earliest phases of human thought, that in the judgment of Professor Max Muller 'the idea of a humanity emerging slowly from the depths of an animal brutality can never be maintained again.'

The object of this brief sketch of the results already attained by the science of comparative mythology, will have been fully attained if it leads the reader impartially to examine the evidence which may be adduced for and against the several propositions under which its conclusions may be summed up. A more complete account of the subject will be found in Max Müller's 'Comparative Mythology,' in *Oxford Essays* for 1856; *Lectures on Language*, second series, by the same author; Bréal, *Hercule et Cacus*, and *Le Mythe d'Œdipe*; Cox's *Tales of the Gods and Heroes*, and *Tales of Thebes and Argos*; Dasent, *Popular Tales from the Norse*; Grimm, *Deutsche Mythologie*; Welcker, *Götten-lehre*; Creuzer, *Symbolik der Alten Völker*; Kelly, *Indo-European Folklore*, &c.

Mytilaceans (Gr. μυτίλος, Lat. mytilus, *a mussel*). The name of the family of Lamellibranchiate Molluscs having the genus *Mytilus*, or common mussel, for its type, and characterised by the mantle being open anteriorly, and by having a foot either sufficiently developed for the office of progressive motion, or serving to draw out, direct, and fix the byssus.

Mytilus (Lat.). A name applied by Linnæus to all Testaceous Vermes which have a bivalve shell, rough, and generally affixed by a byssus, with a hinge, mostly without teeth, generally with a subulate, excavated, longitudinal line. The species comprehended under the above phrase are placed by Cuvier in the Testaceous order of Acephalous Molluscs, and have been subdivided into the genus *Mytilus* proper (of which the common edible mussel, *Mytilus edulis*, is an example); *Modiolus*, Lam.; *Lithodomus*, Cuv.; *Anodonta*, Brug.; *Avicula*, Brug.; and *Meleagrina*, Lam., which produces the most precious pearls. Extensive establishments are maintained at Ceylon and other places for the express purpose of collecting the *Meleagrina margaritifera*, or pearl oyster.

Myxine (Gr. μύξα, *mucus*). The name of a genus of Cyclostomous fishes, remarkable for their mucous slippery integument: the species called *glutinous hag* (*Myxine glutinosa*) is a native of the British seas; its habits are parasitic, and it is most commonly met with in the interior of a cod upon whose flesh it has been preying.

N

N. One of the liquid series of letters. It is common to all known languages, and is interchangeable, more particularly in the Latin, Greek, and other cognate languages, with a variety of letters. As an abbreviation, N is used for *north*, *numero*, &c.; N.B. for *nota bene*; N.L. for *non liquet* (i.e. the case is not clear enough to pass sentence on); N.P. for *notarius publicus*, &c.

Nablum. One of the most famous musical instruments among the Hebrews. Its form and nature are so little known that Calmet thinks it was a harp, Kircher a psaltery or stringed instrument of percussion played on by sticks, and Harmer (*Observations on Scripture*) hints at its being a bagpipe. Bythner (*Lyra*) says that it was like a leathern bottle, explaining his meaning to be that it bore a resemblance to the ancient Greek and Roman lyre, the body of which was made of the shell of the tortoise. The authority of Josephus (*Ant. Jud.* vii. 3. 12), if to be relied upon, distinctly shows it was not an instrument of percussion, but played upon with the fingers; his words are, ἡ νάβλα, δώδεκα φθόγγους ἔχουσα, τοῖς δακτύλοις κρούεται. Its having twelve

sounds, without telling how those sounds were produced, whether by strings or wind, leaves the matter so doubtful that the reader must decide for himself.

Nabob (a corruption of nawâb, from naib, *a deputy*). The title of the governor of a province or commander of an army, in India, under the rule of the Moguls. The nabob was, properly speaking, a subordinate provincial governor under the subahdar; i. e. governor of a subah, or larger province. In the decay of the Mogul empire, many of the nabobs became virtually independent, until their dominions were reduced by the English. The term *nabob* is vulgarly applied to Europeans who have amassed a large fortune in the East Indies, and live in Eastern splendour.

Nabonassar, Era of. In Astronomy, an era, followed by Hipparchus and Ptolemy, and adopted from the Chaldean astronomers, who had been in the habit of referring the observations of eclipses to the beginning of the reign of Nabonassar, the alleged founder of the Babylonish empire. This era Niebuhr (*Lectures on Ancient History* i. 29) regards as 'firmly established in history,' while he looks on Nabonassar as a prince who shook off the Assyrian yoke, and re-established the independence of Babylon. But while Niebuhr regards this fact as placed beyond all doubt, Sir G. C. Lewis (*Astronomy of the Ancients*, 428) regards the astronomical canon for the period before Cyrus as 'a complete historical puzzle,' and remarks that 'the name of Nabonassar, from whom the era is denominated, is unknown to us from any other source.' His conclusion is that the canon is referred to an arbitrary date, altogether beyond the evidence of history. Mr. Grote (*History of Greece*, part ii. ch. xix.) states that 'the earliest Chaldean astronomical observation, known to the astronomer Ptolemy, both precise and of ascertained date to a degree sufficient for scientific use, was a lunar eclipse of the 19th of March 721 B.C., the 27th year of the era of Nabonassar,' which begins with February 26, 747 B.C.

Nacarat (Span. nacar, *mother of pearl*). A term applied to a pale red colour with an orange cast. The *nacarat* of Portugal is a fine linen fabric, dyed fugitively of this tint. The brightest red crapes of this kind are manufactured by the Turks of Constantinople. (Ure's *Dictionary of Arts*.) [ROUGE.]

Nacrite (Fr. nacre, *mother of pearl*). A talcose silicate of alumina, consisting of minute scales, with a glimmering pearly lustre.

Nadir (Arab. nazeer, *opposite*). In Astronomy and Geography, the point of the heavens diametrically opposite to the zenith. The zenith and nadir are the two poles of the horizon.

Nænia (Lat.). A funeral dirge sung to the music of flutes. The Romans personified Nænia, her chapel being built outside the walls near the Viminal gate; her worship was probably designed to procure rest and peace for the dead.

Nævus (Lat.). A spot or mark upon the skin of children at birth.

Nagelfluhe (Ger.). A Swiss and Italian deposit of the Miocene or middle tertiary period, part of it being magnificently developed at the celebrated hill of the Superga near Turin. The rock is generally a mass of conglomerate, and is locally very thick.

Nagyagite. A native telluride of lead and gold, found at Nagyag and Offenbanya, in Transylvania.

Naiads (Gr. Ναΐδες, a word akin to *νάω*, *I flow*; *ναῦς*, *a ship*; Lat. nare, *to swim*; the Sanscrit root being snâ, *to wash*). In Greek Mythology, female deities who presided over fountains, rivers, brooks, &c. The number of these goddesses was indefinite. [NYMPHS.]

Naiadaceæ (from Naias, one of the genus). A group of aquatic inconspicuous monocotyledons, found both in salt and fresh water. [FLUVIALES.]

Nail (Ger. nagel, Gr. ὄνυξ). This term is given to the terminal horny appendage of the finger and toe when they are in the form of flattened or depressed plates, serving to support a broad tactile surface, as in the human fingers. When these appendages are compressed, curved, pointed, and extended beyond the digit, they are called *talons* or *claws*, and the animal bearing them is said to be *unguiculate*; when they encase the extremity of a digit like a box, they are called *hoofs*, and the animal is *ungulate*.

Nais (Gr. ναΐς, *a naiad*). The name of a genus of minute Abranchiate Anellides, or red-blooded worms, remarkable for their powers of reproducing parts of the body when mutilated; and for procreating their kind by spontaneous separation of the hinder segments of the trunk.

Naked Flooring. In Architecture, the timber work of a floor, which supports the boarding, or ceiling, or both of these means of covering.

Name (Lat. nomen, Fr. nom). The designation by which any individual is known. The custom adopted in personal nomenclature has been based on some uniform principle since the earliest ages; modified, however, by the varying circumstances of different countries, and according to the more or less advanced state of civilisation of every people. Thus in the early state of society of the Jews, Egyptians, Persians, Greeks, Romans, Germans, Gauls, Britons, and indeed of every nation, no one had more than one name; but in a more advanced period one or more additional names were given, in order to mark the different families to which individuals belonged, as well as to distinguish members of the same family from each other. To effect these objects the ancient Romans, at least those of good family, generally used three names—the *prænomen*, the *nomen*, and the *cognomen*; the first, which was given on the assumption of the toga virilis, marked the individual, like our Christian name; the second distinguished the GENS, and

the third the FAMILIA, to which he belonged. To these, however, was sometimes added a fourth name, called the *agnomen*, derived from some distinguishing peculiarities in each individual's character or condition; thus Publius Cornelius Scipio was named *Africanus*, from his exploits in Africa. The mode of designation adopted in all the countries of modern Europe is founded on a principle somewhat analogous to that of ancient Rome; with this prominent difference, that in the former no *nomen* or *clan* appellation intervenes between the *prænomen* (or Christian name) and the *cognomen* (or surname). [SURNAME.]

Nandu. The name of the American ostrich (*Rhea americana*). [RHEA.]

Nankeen. A yellowish or buff-coloured cotton cloth, largely manufactured at Nankin in China. Its colour is that of the cotton wool of which it is manufactured. They are sometimes bleached, and then are called *white nankeens*. Imitation nankeens are manufactured at Manchester; but these are confessedly of an inferior quality to the Chinese, neither lasting so long, nor holding their colour so well.

Nantes, Edict of. [EDICT.]

Naos or Nave (Gr. *ναός, a house* or *temple*). In Architecture, that part of a temple which is enclosed by the walls. The part in front of it was called the *pronaos*, the part that occupied the rear being called the *posticum*. In modern ecclesiastical architecture the term *nave* is applied to the middle part or alley of a church, between the aisles or wings, to the west of the transepts and choir.

Naphtha. This term, originally applied to one of the products of the distillation of pit coal, has been extended to a variety of native hydrocarbons, issuing often in large quantities from fissures in connection with coal strata and in other localities. The Burmese petroleum or naphtha has long been celebrated; it issues from a sandy loam resting on bituminous shale, and coal strata, and is used in lamps, and mixed with earth for fuel.

Enormous quantities of naphtha, under the name of *rock oil*, have been imported from Canada and from the United States. The Mecca wells of Ohio are sunk in a sand-stone saturated with the oil, and have yielded from twelve to twenty barrels of oil daily. One of the Canadian wells is said to have yielded a thousand gallons an hour, much of which ran to waste from want of means to store it. These supplies are apparently inexhaustible, and have led, as already stated, to large importations into this country, where the oils are used for various purposes. It need scarcely be observed, that on account of the ready and dangerous inflammability of all these products, careful precautions against fire are requisite in the warehouses in which they are stored.

When these oils are subjected to fractional distillation they are separable into several distinct hydrocarbons, and they differ in composition and in specific gravity accordingly; that of rock oil varies from 0·830 to 0·890, and their boiling points are liable to corresponding variations. (Mansfield, *Quart. Journ. Chem. Soc.* i. 252; De la Rue, *Proceedings of the Royal Society*, viii. 221.)

Naphthalene or Naphthalin. This is a solid hydrocarbon $= C_{20}H_{10}$, formed during the destructive distillation of pit coal for the production of gas. It is obtained by redistilling the coal tar. It is a white crystalline substance, heavier than water, and of a peculiar aromatic odour. It is extremely volatile (fusing at 180°), and its vapour condenses in large white flaky crystals. It burns with much smoke. It is soluble in alcohol and ether. This substance has given rise to an infinity of compounds with acids, chlorine, bromine, &c. none of which are of practical importance, but curious in reference to the substitution of compounds, and to the nomenclatural difficulties in which they are involved. (Miller's *Elements of Chemistry* iii. 667.) In some of our gas-works naphthalene is occasionally formed in such quantities as to produce much inconvenience by plugging up the service pipes.

Naphthalic Acid. *Phthalic Acid.* A crystalline product obtained by the action of nitric acid on naphthalin: it has also been similarly obtained from alizarin.

Napier's Bones or Rods. An instrument contrived by Lord Napier, the inventor of logarithms, for facilitating the performance of multiplication and division. It was described by Napier himself in his *Rabdologiæ*, Edinburgh 1617; a short explanation is also given in the *Penny Cyclopædia*. Although interesting as a curiosity, the instrument is practically useless.

Naples Yellow. A celebrated yellow pigment, formerly made by a secret process at Naples, and used not only in oil painting, but as an enamel colour; it is said to be a mixture of the oxides of antimony, lead, and zinc.

Napoleon, Code of. In 1802, during the temporary calm of the Peace of Amiens, Napoleon, then First Consul, undertook the great task of forming a civil code. It was intrusted to a commission of the council of state; of which Tronchet, Rœderer, Portalis, Thibaudeau, Cambacérès, Lebrun, were the leading members. 'Tronchet' (said Napoleon himself to Las Casas) 'was the soul of the code.' (*Memoirs*, part iii. 234.) Portalis has also the credit of an important share in its composition. But Napoleon himself took great interest in the subject, and mingled eagerly in the discussions of the commission, as appears by the procès-verbal of those discussions. After all allowances made for the unparalleled flatteries of the Napoleonists, his remarks are said to show great intuitive sagacity, much readiness, and a peculiarly enquiring disposition, which often led him to the principles of things, while men of less natural power and trained in a different school were busying themselves unprofitably with the matters on the surface. 'I had at first fancied,' he says, 'it would be possible to reduce all laws to simple geometri-

cal demonstrations, so that every man who could read and connect his ideas together would be able to decide for himself; but I became convinced almost immediately after that this idea was absurd.' (Las Casas, *Mem.* part vi. 263.) Still, according to himself, he continued to cherish the scarcely less absurd idea that no other laws might be necessary than those inserted in the code. The second volume of the work of Thibaudeau (*Sur le Consulat et l'Empire*) is perhaps the most useful to consult for the history of these discussions. According to him, the secretary Locré did not in any degree improve the speeches of the First Consul in his report. Although the ideas of Napoleon himself are said to have entered largely into the composition of the code, it does not appear clearly in what important particulars this was the case; except in one singular instance, that of the law of divorce (book i. title 6), the liberty of which he is said to have greatly promoted. The Code Civil is composed of a great number of laws, dated from the '14 Ventose, an 11' (March, 1803), to 24 Ventose, an 12 (March, 1804), in which latter month they were united in a single code; and which was republished under the empire in 1807. The 'Code de Procédure Civile' was put in force on the 1st of January 1807; the Code of Commerce dates from the same year; the 'Code d'Instruction Criminelle' from November 1808; the 'Code Pénal' from February 1810; which last is a revision of the 'Code Pénal' and 'Code des Délits et des Peines' of the Revolution. But the 'Code Civil' is that to which the term 'Code Napoléon' is in common language particularly applied. It consists of three books; the first 'of persons,' subdivided under eleven titles; the second 'of goods (biens), and the different modifications of property,' comprising four titles; the third 'of the different manners in which property is acquired,' with twenty titles. These last are again subdivided into chapters and sections; and the whole code consists of articles numbered in arithmetical order through the whole, in all 2281. The most important provisions of the code as to the civil state of persons are those relating to marriage and divorce. With regard to property, its fundamental law is that of equal succession by heirs, the abolition of most distinctions between landed and movable property, and the restraint imposed by it on the testamentary power. In the general character of its system, the Code Napoléon merely consolidated the revolutionary laws already existing. [CODE.]

Narceia (Gr. *νάρκη, numbness*). One of the vegeto-alkaline bases, contained in opium, and discovered by Pelletier in 1832. Its medical virtues have not been ascertained. Its composition is said to be $C_{28}H_{20}O_{12}N$. [OPIUM.]

Narcissus (Gr. *νάρκισσος*). In Botany, a genus of Endogens belonging to the natural order *Amaryllidaceae*, among which it is known by its flowers growing upon a scape, and having a cup at their mouth, the stamens opposite the sepals being longer than the others. The species are very numerous; and from their delicate shape, soft and various colour, and sweet scent, have long been favourite objects of cultivation, especially the Daffodils, Jonquils, and Tazettas. Some of the more hardy species grow wild in our woods and under our hedges; but the finer sorts are natives of more southern latitudes. They are divided into several groups or subgenera, of which the principal are: *Ajax*, the Daffodils; *Ganymèdes*, the Rush Daffodils; *Hermione*, the Polyanthus Narcissi; and *Queltia*, the Mock Narcissi.

NARCISSUS. In Mythology, the beautiful son of Kephisus and the nymph Liriope. The legends connected with his name are by no means consistent. According to one version, he was insensible to the feeling of love, and Echo, failing to win his affection, died of grief; as a punishment, Nemesis made him fall in love with his own image, reflected in water, and Narcissus in his turn pined away from unsatisfied longing. The story of his metamorphosis into the flower, so called, is given only in the version adopted by Ovid, and this version says that he killed himself, and that the flower sprang from his blood; while Pausanias, earnestly combating the proposition that Narcissus was so stupid as to be unable to distinguish a man from a man's shadow or image, maintains that he looked at his image in a well to remind himself of a sister whom he had loved and who had died. He is sure, however, that the flower existed before Narcissus, because Persephonê was gathering narcissi in the fields of Enna when she was stolen away by Hades. To so devout a believer in the supernatural, the proof was conclusive; but these inconsistent versions show at the least that the idea of an actual metamorphosis was of comparatively late growth.

Narcogenine (a product of narcotine). A basic substance resulting from the oxidation of narcotine.

Narcotics (Gr. *νάρκη*). Medicines which produce drowsiness, sleep, and stupor. Some of them appear, in the first instance, to act as stimulants, quickening the pulse, and rousing the energy of the nervous system; and, in very small doses, this is their most obvious operation. In larger doses these effects are followed by a tranquil state of mind, torpor, and even coma. Considerable skill and experience are required in the successful administration of these medicines, both as regards the cases in which they are to be prescribed, the doses in which they are to be given, and the peculiarities of habit which often interfere with and modify their usual effects. They are to be distinguished from *sedatives*, which do not produce preliminary excitement. Opium is a narcotic, henbane a sedative. [ANODYNES; HYPNOTICS.]

Narcotine (Gr. *νάρκη*). ($C_{48}H_{24}O_{14}N$.) A crystallised substance, obtained by digesting opium in ether. It was discovered in 1803 by Derosne, and supposed to be the narcotic principle of opium; but this has since been shown to

reside more exclusively in *morphia*, and narcotine is possessed rather of stimulant qualities, and is the cause, perhaps, of the excitement which opium occasions; the statements, however, as to its medicinal action are much at variance. Narcotine is almost insoluble in water and in weak solutions of ammonia and potash. Alcohol and ether dissolve it, but not very freely. It fuses at 268°, and concretes into a crystalline mass on cooling.

Nard (Gr. *νάρδος*). The Nard of the ancients, or Spikenard as it is usually called, is now believed to have been the produce of a dwarf Valerianaceous herb, found in Nepal, and known to botanists as the *Nardostachys Jatamansi*. The roots are said to be very fragrant.

Nardoo (its native name). The *Narsilia macropus*, or, as it is sometimes called, *N. salvatrix*, the spores and spore-cases of which are pounded by the native Australians and made into bread or porridge.

Narration (Lat. narratio). In Rhetoric, the term usually applied to the second division of an oratorical discourse, in which the facts of the case are set forth from which the orator intends to draw his conclusions.

Narthex (Gr. *νάρθηξ*). The first section or division in the Roman basilicas, allotted especially to the monks and to women, and used for rogations, supplications, night-watches, and as a place for the dead during the performance of the funeral rites. The catechumens, the energumeni (or persons supposed to be possessed by evil spirits) and the lapsi (or persons who had denied their faith during times of persecution) were also restricted to this part of the building. The baptistery was distinct from the narthex, being reckoned among the *exedræ*, or appurtenances of the basilica. (Hook's *Church Dictionary*.)

NARTHEX. The genus of Umbellifers from which the drug Asafœtida is obtained. [ASAFŒTIDA.]

Narwhal. The common name of the species of Cetacean which has a single long protruded tusk. [MONODON.]

Nasal (Lat. nasus, *nose*). A nasal pronunciation is given in some languages to particular letters, as in French to the letters *n* and *m* in certain positions. The only sound approaching to nasal in English is that of the double consonant *ng*; as in *thing*, *ring*, &c.

Nasalis. [SEMNOPITHECUS.]

Nascent State. Chemists generally apply this term to gaseous bodies at the moment of their evolution, as it were, from liquids or solids, and before they have assumed the aëriform state. There are numerous cases in which bodies, having no tendency to combine under ordinary circumstances, readily unite when presented to each other in their nascent states. Hydrogen and nitrogen gases, for instance, when mixed together, show no disposition to combine; but when certain organic bodies containing those elements are heated, they are evolved in their nascent states, and combine so as to form ammonia; it is in this way that ammonia is abundantly produced during the destructive distillation of many kinds of animal matter, and of pit coal. Hydrogen gas has no action, under ordinary circumstances, on sulphur or on arsenic; but when sulphide of iron or arsenide of zinc are acted on by dilute sulphuric acid, the hydrogen, at the moment of its evolution, combines with the sulphur and arsenic to form sulphuretted and arsenuretted hydrogen. The destructive distillation of organic substances in general furnishes abundant and important instances of these nascent combinations.

Nasturtium (Lat.). The scientific name of a genus of Cruciferous plants of weedy character, some of them found in this country, the most important being the Water-cress, *N. officinale*. It is also a popular or garden name for the *Tropæolum* or Indian Cress, doubtless from some fancied resemblance in its properties to those of the true [

Nasua (Lat. nasus, *a nose*). A genus of Plantigrade Mammalia, so called from the remarkable elongation and upward curve of the nose. The species of this genus, *N. rufa*, or red coati, and *N. fusca*, or brown coati, are both natives of South America. They climb trees in pursuit of birds, and to rob their nests; they burrow for shelter at the foot of large trees, and often undermine them to such an extent that they are liable to be overturned even by a slight wind.

Nasuta (Lat. nasus). A term in Zoology, signifying the prolongation of the muzzle into the form of a nose, as in the *Perameles nasuta*, *Pleuronectes nasutus*, *Truxalis nasutus*; or the developement of the integument of the face above the muzzle, forming a true nose, as in the *proboscis* monkey, *Simia nasuta*. Illiger called a family of Multungulate quadrupeds with the nose prolonged beyond the jaws, and movable, as in the tapir, *Nasuta*.

Natatores (Lat. from nato, *I swim*). Swimming birds. The name of the order of birds including those in which the toes are united by a membrane, whence the order is also termed *Palmipedes*. The legs are placed behind the equilibrium, and the body is covered with a thick coat of down beneath the feathers. [ANSERES; ANATIDÆ.]

Natatory. In Zoology, a term used to denote that a locomotive extremity, or other part, is provided with a membrane, or with close-set hairs, by which it is adapted for displacing water.

Nation (Lat. natio, from nascor, *to be born*). A collective appellation for a people inhabiting a certain extent of territory under the same government. The word is also used in some universities, by way of distinguishing students of different districts or countries, as the case may be. This latter meaning is borrowed from the custom of the university of Paris previous to the institution of faculties, when those who resorted to it from different countries lived under the same institutions

and masters; a *common country*, however, being the only bond of union.

Nations, Law of. [LAW.]

National Debt. In Finance. Under the names of benevolences and loans, the English sovereigns had for centuries increased, whenever necessity pressed them, such resources as could be derived from their estates, from their feudal rights, and from parliamentary taxation. It is hardly needful to say that these debts were rarely repaid, and that parliamentary supervision over such parts of the revenue as were applied to the public service was, except in rare cases, unpractised and unknown. When these methods of raising funds were declared illegal, monarchs sometimes resorted to violence, as Charles I. and Charles II. did in the seizure of the merchants' and goldsmiths' deposits; sometimes they borrowed on their personal security, as Charles I. borrowed from the colleges of Oxford and Cambridge, from the Cavaliers, and the loyal corporations; sometimes they sold their possessions, as Charles II. sold Dunkirk; sometimes they even submitted to be the annuitants of foreign sovereigns, as the same monarch was of Louis XIV. A parliamentary guarantee was out of the question, for the effective existence of such a security implied the collateral necessity of parliamentary superintendence and control, and a far greater political independence than the house of Stuart could have endured, or indeed ever suffered. Had the course of events which led to the Revolution taken a different turn, James II., who was an economical and thrifty sovereign, might perhaps have so husbanded his ample revenue as to have rendered himself at once independent of his parliament and of Louis. But the Revolution threw the crown entirely into the hands of the House of Commons, and made the monarch, by virtue of its fundamental principles, wholly dependent upon the people for his supplies. Public debts had been created by the Dutch long before the era of the Revolution, and there cannot be a doubt that if an effectual guarantee had been possible, securities analogous to those created at the Revolution would have been negotiated during the Spanish and civil wars, and even during the time in which the nation was bent on recovering the Palatinate.

It is true that at the Revolution the new settlement was in great danger, but it may be doubted whether the danger was really understood. At the present time, when the worthlessness of most of the persons who joined the standard of William is known, it is quite possible to be wise after the event; but it is not likely that the public were alive to the perfidy of the men who, surrounding the throne of William, made ardent professions of loyalty, and all the while corresponded with the court at St. Germains. The intrigues of Louis XIV. and the defence of the Netherlands were the occasions by which the new parliamentary system was enabled to assert its authority over the revenue, to give the most satisfactory pledge of its power, by inducing subscriptions on the part of the mercantile public for the relief of government necessities, and to prove itself, in great degree at least, the expressed voice of the people at large. It is impossible to conceive the existence of a national debt, except on the hypothesis of parliamentary independence, because, unless the nation be personally pledged to the obligation, the security is worthless.

In order of time, the oldest part of the national debt is the composition made to the bankers for the seizure of their deposits, i. e. 1,328,526*l.*, in the Exchequer on the 6th of January, 1672. To still the panic which ensued upon this robbery, the king promised to pay interest at the rate of six per cent. on the sum appropriated; but, as might be expected, he broke his word, paid no interest, took no steps to liquidate the obligation, and the bankers nearly thirty years afterwards were obliged to accept a composition, by which interest at the rate of three per cent. was secured on the debt, with the option of redemption on repayment of half the principal. The actual debt was thus reduced to 664,263*l.*, and nearly the whole was absorbed in the subscription of the South Sea Company's stock in 1720, thus forming the earliest part of the national debt, being that only which was increased before the Revolution.

It has been observed above [FUNDS, PUBLIC], that originally the word *fund* was applied to the source from which the means for paying interest and (where the debt was terminable) the principal were to be derived, and that much of the public debt, when interpreted according to the amount originally contributed to the exigencies of government, is fictitious. [FUND, SINKING.]

During the greater part of the eighteenth century, loans were negotiated in a number of stocks. For instance, the subscriber of 100*l.* received a certain amount in consolidated annuities at three per cent., a certain amount in a four or five per cent. stock, and a terminable annuity. Hence the creation of that which was called *long annuities*; the extinction of which has been a considerable relief to the revenue of late years. But it has been found that the terms on which long annuities have been granted have been exceedingly disadvantageous to the borrowers, the worth of the annuity having been generally far in excess of the money advanced. This was still more notably the case in government life annuities; in regulating which, the government habitually granted an annuity worth fourteen years' purchase when the actual value of the life was not more than ten years' purchase.

The bank of England has always negotiated the government loans, and received a fixed sum for the same. Originally the interest on the several funds was paid at the Exchequer. But part of the South Sea scheme was the consolidation of all the funds, with a view to their being managed by the company, who were

to make themselves responsible for the interest. Gradually the whole management of the debt, the payment of interest, the circulation of Exchequer bills, and all the other offices connected with the financial acts of the government, have been conferred on the Bank, which receives a stated annual sum in compensation, with the use of the Exchequer balances remaining in their hands. This payment is 300*l.* per million on 600 millions, and 150*l.* per million on all above 600 millions. Thus, in 1863 the Bank received 180,000*l.* for the first-named portion, and 20,224*l.* for the management of 134,827,423*l.* The payment of interest on the government annuities forms another item in the expense of management, this payment being provided for at the National Debt Office.

The public debt is divided into that contracted for Great Britain and Ireland; each of these heads is further subdivided into permanent funded debts and terminable annuities, and again into the various stocks, created either by original loan, consolidation, or reduction, with charges of interest on each portion. This state of the debt on March 31, 1863, is given in Table I. with the purpose of exhibiting the form in which the debt and charges are presented to parliament in the annual volume of miscellaneous statistics.

The debt has grown during periods occupied by foreign wars. This gradual growth is shown in Table II. with the diminutions which have been effected in its amount during times of peace. The redemption amounts to less than ten per cent. upon the capital created. For the expedients which have been from time to time adopted, for the purpose of liquidating public obligations either in whole or part, see FUND, SINKING.

It is not possible to separate from the ordinary consequences of taxation in general the effects of so large an annual deduction from the profits of the nation, in order to meet the interest to be paid on those public debts which have been created upon the guarantee of national honour. These profits are at present mulcted to the extent of twenty-six millions a year; and if it were possible to free industry from so vast an incumbrance, and to permit the accumulation and productive employment of so large an amount of a nation's annual earnings, it would seem that industrial efforts would be recompensed by a far larger share of prosperity than they can attain under the pressure of such enormous annual obligations. But though taxation diminishes the quantity of enjoyments possessed by the contributor, it does not follow that it cripples the collective energy of a nation. It may, and often does happen, that taxes paid to government are deductions from unnecessary expenditure, and that the proceeds of these taxes are devoted towards the maintenance of labour, and even of productive labour. If indeed a war expenditure is rendered necessary in order to support the independence or political existence of a nation, however much the charges may press upon individuals, its effect on a community is rather to displace a portion of profit, which may have been spent as well as saved, from particular persons, in order to invest it in permanent advantage to the nation at large. Government expenditure, even for war, is not necessarily a public loss, however just it may be that war should not be undertaken except under the pressure of overwhelming necessity, and should be, as far as its burdens and charges are concerned, so distributed as to affect as evenly as possible all classes alike. The pressure of the interest on the public debt is to be considered, therefore, much more as affecting the power of expenditure possessed by individuals, than as really affecting national resources. [TAXATION.]

Unlike almost all other nations, the English people has consistently recognised the sanctity of its public obligations; and if repudiation has ever been recommended, it has been by obscure persons, who have been met by indignation or contempt. Sometimes indeed it has been argued that the act of a generation by which it pledges posterity to the liquidation of debts incurred in the interest of a bygone policy, or a temporary advantage, is not and should not be binding on posterity. But such reasoning ignores the greatness of the inheritance which has been received from our ancestors, and is of the same nature as the morality which would accept the estate of another, and dispute the debts which have been contracted for the purpose of defending, improving, and securing the estate. Even if the political action of our forefathers was not wise (and much if not by far the greatest part of the national debt was contracted for unreal or illusory objects), supposed value was taken by the act, and real value received for the obligation. So if an heir received an inheritance from his ancestor, and on taking possession discovered that large debts were due from the estate, for instance, in consequence of extravagant expenditure on an election, no one would admit the plea that the futility of the purpose for which the liabilities were incurred, or the folly of the ancestor, entitled the heir to dispute or deny the debt, if the debt were bonâ fide, and for value legally received. It is just indeed that those who have received the largest share of the inheritance, or have derived the greatest advantage from the outlay, should be liable to the largest portion of the obligation.

In the debates which took place at the conclusion of the Continental war, many persons advocated the resumption of cash payments, in a depreciated currency, suggesting for instance that the sovereign should contain fifteen shillings' worth of gold only, and urging that as gold had stood for several years at a premium equivalent to such a depreciation, and as large part of the public debt had been created in paper having a forced circulation, it was just that the payment of the interest on the debt should be made at the actually low, and not at the nominally high rate in which the securities were originally funded. The plan failed, and most righteously. Only one part of the state-

ment was true, and all the reasoning was fallacious. It was true that a large, but certainly not the largest, part of the existing debt had been created in a depreciated paper. But the terms on which the loan was made implied, according to parliamentary guarantee, a resumption of cash payments within a year after peace was declared; and it is matter of history that steps were not taken to redeem this pledge till three years after the occurrence of peace, and even then that very gradual justice was done to the fund-holder. Again, during the whole time that the paper was depreciated, the holders of all stocks created before the war, and before the Bank paper was at a discount, were paid in a medium which reduced the actually receivable dividend by the full amount of the depreciation, and so had inflicted a considerable wrong on the public creditor. In short, the scheme, amounting to a repudiation of a fourth of the national debt, was as sophistical as it was dishonest, and would have been assuredly suicidal.

Real reductions have been made in the amount of the debt by diminutions in the rate of interest. By far the largest portion of the debt consists of permanent annuities, analogous in their nature to a perpetual mortgage, in which the mortgagee foregoes his right of demanding payment, but the mortgagor retains the privilege of extinguishing his obligation by repayment. Hence when the price of the security exceeds its nominal value, it becomes possible to create a new debt for the purpose of extinguishing the old, the new debt being negotiated at a lower rate of interest. At different periods, advantage has been taken of the high value of public securities to perform this operation. This was first done on a large scale, after several previously ineffectual attempts, in 1749, and the fund created formed the basis of the consolidated annuities, of which more than half the public debt consists. Of late years a 2½ per cent. stock has been formed.

The actual burden of the public debt and the virtual reduction of its incidence are relative to the annual income of the nation. Obligations once exceedingly onerous are now comparatively easy, because the wealth and [r]ts of the nation have so largely increased. At the peace of 1815, the charge of the debt absorbed the greater portion of the annual revenue; at the present time, although reduced in amount by little more than six millions, it does not form much more than a third of the expenditure, the larger revenue being derived with less difficulty and far less personal sacrifice than during the years which followed on the cessation of the great European war.

It would seem that the best means by which debt can be cancelled, is by the creation of long annuities. There is very little difference in market value between an annuity of 100 years and a perpetual payment, although of course the difficulty of estimating the present value of a long annuity by an individual renders it next to impossible that such securities should be circulated widely among the general public. But there is a class of institutions peculiarly fitted for the negotiation of such securities, namely insurance and finance companies, who, it may be supposed, on certain advantages being offered, might be induced to make considerable investments in long annuities, and be able to recoup themselves by the creation of a reserve corresponding to the annual depreciation of the principal sum. At present only about 17[?] millions of public debt is in the course liquidation by these means.

Public securities present certain advantages to investors, and are protected by certain privileges. No duty is levied on purchase and sale; brokers are obliged to transact business for their clients in public stocks at certain fixed rates; and till lately personal property in the hands of trustees, which they were not expressly authorised by the instrument of trust to invest otherwise, was compulsorily invested in consols. Besides, consols may be, and constantly are, pledged in order to procure bankers' advances, and so to a great extent fulfil the function of deposit accounts. But it may be doubted whether these securities are ever likely to be at par again. So many new advantageous, and apparently safe objects for the investment of capital have been and are discovered, and the principle of limited liability is being applied so extensively to commercial undertakings, and is absorbing savings on so large a scale, that the attractions of these investments come powerfully into competition with the feeling and desire of security which led to the selection of consols. The fact is significant, because if consols remain permanently below par, the prospect of reducing the incidence of the debt by conversion into stock of a lower denomination is finally shut off, and the only means by which the amount can be lessened will be by the continual excess of income over expenditure, or by the adoption on a large scale of a system of long annuities, by which the extinction at some future time of a large portion of debt will be effected at a small increase of annual payment for a period.

The liability of each person, in the population of the several European states, towards the public debt, is greatest in Great Britain and Ireland, and least in Switzerland; in the former amounting to 27*l.* 15*s.*, in the latter to 1*s.* 3*d.* The Netherlands come after England, and next France. The French debt is on this calculation less than half the English proportion. On the other hand, the burden of interest is higher proportionately in France than in Great Britain; for though the English debt is so large, it must not be forgotten that its magnitude is due to the fact, that, unlike almost any other, this country *has never* (with the exception of part of the banker's debt, already noticed) *repudiated any of its obligations.*

TABLE I. *Amount of each* DESCRIPTION *of the* PERMANENT PUBLIC FUNDED DEBT, *and of the* TERMINABLE ANNUITIES, *in* GREAT BRITAIN *and* IRELAND *respectively, and of the* UNFUNDED DEBT *of the* UNITED KINGDOM, *with the Amount of* ANNUAL INTEREST PAYABLE ON EACH KIND OF DEBT, *on March* 31, 1863, *and the* AMOUNT PAID *for the* MANAGEMENT *of the* PERMANENT DEBT *in the same Year.*

Description of Debt	Rate of Interest	Amount of Debt	Annual Interest
GREAT BRITAIN.		1863	1863
Permanent Funded Debt:—	Per cent.	£	£
New Annuities	2½	2,949,667	73,741
Consolidated Annuities	3	400,237,351	12,007,120
Reduced Annuities	3	114,198,564	3,425,956
New Annuities	3	213,130,895	6,393,296
Bank Debt	3	11,015,100	330,453
New Annuities	3½	240,746	8,426
Ditto	5	430,603	21,530
Exchequer Bonds	2¾	418,300	11,503
		742,621,226	22,272,025
		Estimated Capital of Debt.	
Terminable Annuities:—			
Annuities for life	. .	10,099,660	1,017,668
Annuities for terms of years	. .	639,979	76,200
Annuities 4 Geo. IV. c.22 expiring April 5, 1867	. .	2,168,719	585,740
Red Sea Telegraph Company's Annuity, expiring August 4, 1908 . . .	. .	818,199	36,000
Red Sea Telegraph Company's Annuity, expiring April 5, 1885.	. .	84,794	12,127
Tontine and Exchequer Life Annuities (English)	. .	68,595	18,341
Tontine and Exchequer Life Annuities (Irish)	. .	3,862,105	253,185
		17,742,051	1,999,261
Total Permanent Debt and Terminable Annuities in Great Britain	. .	760,363,277	24,271,286
IRELAND.			
Permanent Funded Debt:—			
New Annuities	2½	3,080	77
Consolidated Annuities	3	5,835,555	175,066
Reduced Annuities	3	137,316	4,199
New Annuities	3	32,076,788	962,303
Bank Debt	3¼	2,630,769	85,500
New Annuities	5	2,000	100
		40,685,508	1,227,245
Tontine Annuities payable in Ireland . .	. .	15,132	4,046
Total Permanent Debt and Terminable Annuities in Ireland	. .	40,700,640	1,231,291
UNITED KINGDOM.			
Total of Permanent Funded Debt . . .	. .	783,306,734	23,499,260
Terminable Annuities . .	. .	17,757,183	2,003,307
Unfunded Debt, Exchequer Bills .	. .	12,895,400	369,876
Exchequer Bonds	. .	6,000,000	123,750
		817,559,097	25,996,193

Cost of Management.

	£
To Bank of England, at 300*l.* per million	180,000
,, 150*l.* ,, ...	20,224
Expense of National Debt Office	14,983
Total	215,207

TABLE II. *Amount of the Principal and Annual Charge of the Public Debt at different Periods since the Revolution.*

	Principal, Funded and Unfunded	Interest and Management
	£	£
Debt at the Revolution, in 1689	664,263	39,855
Excess of debt contracted during the reign of William III. above debt paid off	15,730,439	1,271,087
Debt at the accession of Queen Anne, in 1702	16,394,702	1,310,942
Debt contracted during Queen Anne's reign	37,750,661	2,040,416
Debt at the accession of George I., in 1714	54,145,363	3,351,358
Debt paid off during reign of George I. above debt contracted	2,053,125	1,133,807
Debt at the accession of George II., in 1727	52,092,238	2,217,551
Debt contracted from the accession of George II. till the peace of Paris in 1763, three years after the accession of George III.	86,773,192	2,634,500
Debt in 1763	138,865,430	4,852,051
Paid during peace, from 1763 to 1775	10,281,795	380,480
Debt at the commencement of the American war, in 1775	128,583,635	4,471,571
Debt contracted during the American war	121,267,993	4,980,201
Debt at the conclusion of the American war, in 1784	249,851,628	9,451,772
Paid during peace, from 1784 to 1793	10,501,380	243,277
Debt at the commencement of the French war, in 1792	239,350,148	9,208,495
Debt contracted during the French war	601,500,343	22,829,679
Total funded and unfunded debt on February 1, 1817, when the English and Irish Exchequers were consolidated	840,850,491	32,038,174
Debt cancelled from February 1, 1817, to January 5, 1854	85,538,790	4,163,515
	755,311,701	27,874,659
Debt created by Russian war, 1855–9	68,623,199	652,824
	823,934,900	28,527,483
Cancelled to 1863	6,395,583	2,295,692
Debt and charge, March 31, 1863	817,539,317	26,231,791

See, for the earlier portion, Grellier's *History of the National Debt*; and for the later, Porter's *Progress of the Nation.*

National Defence. The defence of a state or a nation against invasion. The short distance of our shores from those of France rendering us peculiarly liable to invasion in case of hostilities with that country, the best method of national defence for England has been the theme of much contention. Forts, iron-clad ships, larger armies, have been advocated. Within the last few years, large sums of money have been spent on the national defences. Our dockyards are being strongly fortified; iron-clad ships have been built for the defence of our coasts; and large bodies of volunteers have been trained, who could be rapidly massed at one spot, by means of our railways, in the event of a threatened invasion. But it must not be forgotten that all history shows that irregular troops can never successfully oppose regularly disciplined soldiers; and too great a reduction of the standing army should on no account be attempted, while all the powers abroad are so fully armed. To build fortifications without soldiers to hold them, to mount guns without gunners to man them, is useless.

Native Amalgam. A native alloy of quicksilver and silver. It occasionally forms perfect crystals, and is found at Almaden in Spain, Rosenau in Hungary, Moschellandsberg in Deux Ponts, Chili, &c.; chiefly it is said, at the intersection of veins of mercury and silver.

Nativity. In Astrology, a term synonymous with HOROSCOPE.

Natrix (Lat. *a water-snake*). The subgenus of the Linnæan *Colubri*, of which our common harmless snake, *Coluber Natrix*, Linn., is the type.

Natrolite. Prismatic Zeolite. A hydrated silicate of alumina and soda, which occurs in slender or acicular crystals, and in small mammillary fibrous masses of a white, yellowish, or greyish colour.

Natron. *Native carbonate of soda* has long been known under this name, and hence the term *natrium*, applied to sodium by the German chemists, which has led to the adop-

tion of the symbol Na for that metal. It is found in sandy soils of various countries, but more especially in Egypt, where it was anciently employed in the art of embalming. [MUMMY.] It occurs also in Africa, near Fezzan, under the name of *trona*, at Maracaibo in South America, and in large quantities in the plain of Debreczin in Hungary, and elsewhere.

Natural. In Music, a character marked thus ♮. Its office is to contradict the flats or sharps placed at the beginning of a stave or elsewhere, and by its use the note to which it is prefixed returns to the natural scale of the white keys.

Natural History. The history and description of the natural products of the earth, whether minerals, vegetables, or animals, together with a scientific developement of their causes and effects. The several branches of this subject are treated under their respective heads.

Natural Orders of Plants. In Botany, the groups of genera which are supposed to bear a greater resemblance to each other than to anything else. They may be said to be coeval with our knowledge of plants; for the old ideas of grasses, trees, herbs, corn, and fruit trees, indicate a perception of the existence of some such groups. When systematical botany first assumed the appearance of a science, we find the Umbelliferous, Leguminous, Liliaceous, Labiate, and Composite orders, more or less distinctly defined. It is, however, chiefly to the labours of botanists posterior to the days of Linnæus, especially to Jussieu and his followers, that we owe the present improved limitation of natural orders. The most complete account of them in English is in Lindley's *Vegetable Kingdom*, in which 303 natural orders are defined. [BOTANY.]

Natural Philosophy or **Physics.** The science which treats of the properties of natural bodies, and the action of their masses on each other. [PHYSICS.]

Naturalisation. In Law, the process by which an alien is placed in the same civil condition as if he had been born under the dominion of the state. In England, this could formerly take place only by Act of Parliament, but by stat. 7 & 8 Vict. c. 66 an alien may obtain a certificate from one of the principal secretaries of state, conferring on him all the rights and capacities of a natural-born British subject, except those of sitting in parliament and being a member of the privy council. [ALIEN.]

Nature Printing. The art of reproducing and printing on paper botanical specimens of flowers, leaves, or of whole plants, so truthfully that the microscope may detect in the print peculiarities too minute to admit of imitation by any effort on the part of the engraver. The art was first practised by M. Auer, superintendent of the Imperial printing office in Vienna, and was introduced into this country by the late Mr. Henry Bradbury.

The subject to be printed is first *thoroughly* dried by placing it between thick blotting paper, and pressing it in a screw press, frequently changing the paper, and repeating the process until all moisture is extracted; in some instances the services of the sun, or even of artificial heat, are additionally called into requisition. When it is thoroughly dried (and this fact may be ascertained by its brittleness), it is ready for manipulation. The plant may be said to engrave its own plate in this wise: a thick piece of pure soft sheet lead, rather larger than the paper on which the subject is ultimately to be printed, must be planed as bright and even as a looking glass. It may be here mentioned, that Mr. Bradbury found this his only difficulty—and his efforts were for a time completely paralysed; for although the process was perfect in other respects, the plates were *ribbed*, as it is termed, and, when printed, gave impressions of a large number of latitudinal lines not intended to be in the subject. In this exigency he applied to Mr. James Wood, who, by an adaptation of the knife so as to polish and cut at the same time so soft a substance as lead, constructed a machine by which tons of plates have been since satisfactorily planed. Upon the bright prepared lead plate the subject is laid in the position required, and is then passed between powerful rollers of polished steel, until the plant is embedded in the lead, and a fac-simile matrix is the result. Great care and patience now become requisite, the subject having to be disinterred without injury to the lead plate; this is done piecemeal, and the blow-pipe is found to be of great use in burning the particles which cannot easily be got out otherwise; and, as some of the more delicate portions of the lead plates would become fused, and consequently useless, just sufficient flame only is applied to consume the dried fibres. One or two impressions can now be obtained from the lead plate by the copper-plate press, but of course the softness of the lead renders another process necessary for securing large quantities of impressions. The back and edges of the lead plate are therefore covered with a varnish, the face only being left exposed; it is then suspended in an electrotype depositing trough, and a deposit of copper thrown on it, and allowed to remain until the copper has grown to an eighth of an inch in thickness; the lead plate and copper impression are then separated, the copper relief plate in its turn undergoes the varnishing of the back and edges, to prevent the adhesion of superfluous copper, the face being well black-leaded with the purest plumbago (to prevent the two copper plates from incorporating); the relief plate then undergoes the same operation that the lead plate underwent, the result being another deposit the reverse of the first. These in their turn have to be separated, and the climax is arrived at, viz. the production of an engraved copper plate ready for the printer, who inks the plate in such a manner as to represent nature as nearly

as may be, the leaves being green, and the stems and roots brown; he then pulls his impression upon unusually soft paper at an iron copper-plate press, the paper sinking to the full depth of the plate, and an embossed printed picture is the result. (Wood's *Typographical Advertiser.*) The *Ferns of Great Britain and Ireland, with Text by Lindley and Moore,* is one of the most beautiful specimens of this kind of printing.

Nauca. In Botany, a seed in which the scar of the hilum occupies one third part of the external surface, as in the horse chestnut.

Naucrary (Gr. ναυκραρία). Before the time of Solon the naucraries were political divisions of the Athenian people answering to the Demi of the constitution of Cleisthenes. Up to this time they had no connection with the navy, the name probably being derived from ναίειν, *to dwell,* and κλῆρος, *a lot,* with the simple meaning of householder. Afterwards, each naucrary was made answerable for providing a ship of war, and this duty was ultimately developed into the Trierarchy. [LITURGY.]

Naulum (Lat. from Gr. ναῦλος, *passage-money*). In the usage of the ancient Greeks and Romans, a piece of money put into the mouths of deceased persons to enable them to pay Charon for ferrying them over the Styx.

Naumachia (Gr. *a sea-fight*). Among the Romans, a representation of a naval engagement, which took place most usually in theatres (called also naumachiæ) made for the purpose. These exhibitions were originally instituted for purposes of naval discipline; but, in process of time, only malefactors or captives whose lives had been forfeited acted in them. They appear to have been conducted on a scale of such magnificence as almost to exceed belief. Within the places set apart for them whole fleets went through their evolutions. In the sea-fight on the lake Fucinus, given by Claudius, there are said to have been no fewer than 19,000 combatants. Julius Cæsar appears to have first given a naumachia on an extensive scale; his example was followed by many of his successors on the imperial throne; and at last they were frequently exhibited at the expense of private individuals, as a means of increasing their popularity. The seats for the convenience of spectators were arranged in a manner somewhat similar to those in the amphitheatres. [AMPHITHEATRE.]

Naumannite. A native selenide of silver found at Tilkerode in the Harz; and named after Naumann, the Saxon mineralogist.

Nausea (Gr. ναυσία, *qualmishness,* from ναῦς, *a ship*). A sensation of sickness, similar to that produced by the motion of a ship at sea. An inclination to vomit.

Nautilidæ. The family of Cephalopods with siphoniferous shells, of which the *nautilus* is the type.

Nautilus (Gr. ναυτίλος, literally *a seaman*). The name of a genus of Tetrabranchiate Cephalopods, including those which have a chambered shell with simple septa, perforated in the centre, concave towards the outlet of the shell, the last chamber being the largest, and containing the body of the animal.

Naval Architecture. The science of designing the forms for vessels, in order that they may properly fulfil the purposes for which they are severally intended, is distinct from shipbuilding, which is the application in practice of the theoretical designs of the naval architect.

When a ship is to be built, her form is projected in three different planes perpendicular to each other.

1st. The *sheer draught,* which is the side view, or projection on the plane of the keel. On this are laid off the length, the heights of all the parts from the keel, the position and rake of the stem and stern post, the principal frames or timbers of the sides, the ports, decks, channels, place of the greatest breadth or midship frame, stations of the masts, &c.

The frames before the midship frame are distinguished by letters; abaft it, by numbers.

The midship frame is not exactly in the middle of the length, but rather before it.

2nd. The *body plan,* or end view. This shows the contour of the sides of the ship at certain points of her length; and since the two sides are exactly alike, the left half represents the vertical sections in the after part of the body, and the right half those in the fore part. The base of the projection is the midship, or largest section, called also the *dead flat,* within which the other sections are delineated. On this are exhibited also the beams of the decks.

3rd. The horizontal or floor plane, called also the *half-breadth plan.* The base of this is the section made by the horizontal surface of the water and the outside surface of the ship, and is called the *upper water line,* or *load water line.* If the ship now be supposed to be lightened uniformly, she will exhibit another water-line, and thus any number of like parallel sections at equal distances down to the keel.

These three sections correspond to each other upon the same scale; and any point in one is immediately referable to the other two projections.

The sheer draught plan shows length and height, the body plan breadth and height, the half-breadth plan breadth and length. Thus the three dimensions are given each on two plans for every point of the outer frame of the ship.

The water-lines, or lines parallel to the surface of the water, appear on the sheer draught as straight lines parallel to the keel or the upper water-lines; in the body plan, as straight lines at right angles to the keel; and on the half-breadth plan as curved lines.

The lines representing the timbers, or exterior of the cross sections of the ship, appear as curves in the body plan, and as straight lines at right angles to the keel in the other two plans.

The several parts are drawn from these plans in their full size on the floor of the mould loft, and worked by the practical shipbuilder from the moulds or models so taken. A sketch of some of the operations by which the actual ship is produced from the designs of a naval architect will be given under SHIPBUILDING.

The forms of ships vary according to the object for which the vessel is built, and according to the ideas of the architects; for although great steps have been made in this science, it must be confessed that in many points it is still empirical. Results occur which the designers did not anticipate, and the most successful vessels are not always those which by theory should attain the palm. Formerly the vessels of the royal navy, copied from French prizes, were our best models, but in recent years the merchant service has equalled if not surpassed the navy in improvements, great as has been the advance made by the latter. The large clippers built for the Australian trade and the magnificent steamers for ocean navigation have opened a new era in ship construction. The principal improvements have been in the direction of giving increased length, sharper prows, rounder bottoms, and therefore lower centres of gravity.

Numerous experiments have been made to ascertain the best forms for ships. The results may be shortly summed up as follows:—

1. The resistance of the water against the heads of ships varies as the areas of midship sections immersed and as the weights.

2. The centre of lateral resistance is at the middle point of the keel when the ship floats level and is at rest. As speed increases, the centre of lateral resistance moves towards the bow.

3. Stability is increased by increased width and by increased length in an arithmetic ratio. The maximum as regards depth is attained when the depth immersed is one-fifth the beam.

4. Sharper bows give greater speed than bluff bows, and a gently curved line than a straight line. The resistance is also diminished by the sides of the bow being bevelled from the water-line towards the keel.

5. Speed is augmented by the sides tapering in from the midship section backwards towards the stern. This also adds to the steering power. The bottom should also curve up from the midships section towards the stern.

6. Speed is increased by additional length.

7. The immersed portion of the midship section gives most speed when semicircular, least when triangular. A flat rectangle gives most stability, a triangle the least. The flat rectangle draws least water for a given burden, the triangle the most.

8. The pressure for lee-way is as the area of the sheer plan immersed.

9. All lines where resistance has to be overcome should be gently convex.

10. The midship section from which curves start for bow and stern should be nearer to the bow than stern.

11. In all steam vessels the portion amidships devoted to the engine room should float the engines, boilers, and fuel, and nothing else. The ship should therefore be computed for her intended duties, divided in the middle, and the engine room there inserted.

Naval Cadets. Boys training for service as naval combatant officers. They enter between twelve and fourteen years of age, and are required to pass a simple examination. After two years' service the naval cadet becomes a midshipman.

Naval Crown. Among the Romans, a crown, of gold or silver, resembling the prow of a ship, awarded to the man who first boarded a hostile vessel. [CROWN.]

Naval Reserve. An auxiliary naval force formed in 1859 under 22 & 23 Vict. c. 40 for men, and 24 & 25 Vict. c. 129 for officers. It consists of masters of merchant vessels (certificated) as lieutenants, chief mates as sub-lieutenants, and men of all ranks in the merchant service. The men enroll themselves for five years, and are bound to train for twenty-eight days in each year in a ship of war or with the coastguard, as directed. While training they receive naval pay, and as a retaining fee 6*l.* a year. In case of national emergency the reserve may be called out for service in her majesty's ships in any part of the world for a period not exceeding five years. After about the age of forty-five a man of the reserve becomes entitled to a pension of 12*l.* for life, or to a smaller sum for the longest liver of himself and wife. If he have actually served for three years, he is entitled to 2*d.* a day additional.

The officers receive while training or serving, lieutenants 10*s.* a day, and sub-lieutenants 7*s.* a day, with pensions for wounds and (if killed in action) to widows at the same rates as in the royal navy.

The establishment sanctioned by the Acts is 400 officers and 30,000 men. About half that force has been actually enrolled.

Nave. [NAOS.]

Nave of a Wheel (Ger. nabe). The centre part of a wheel. It is usually made solid, and from it the spokes radiate.

Navicular (Lat. navicula, *a little boat*). Boat-shaped. The *navicular* bone is one of the bones of the tarsus. The term is also used in Botany.

Navigation (Lat. navis, *a ship*). That branch of science by which the mariner is taught to conduct his ship from one part or place to another.

To understand the principles of navigation, and their practical application, it is necessary that the mariner should be acquainted with the form and magnitude of the earth, the relative situations of the lines conceived to be drawn on its surface, and that he should have charts of the coasts and maps of the harbours which he

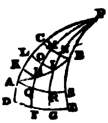
may have occasion to visit. He must also understand the use of the instruments for ascertaining the direction in which a ship is steered and the distance which she sails; and be able to deduce from the data supplied by such instruments the situation of his ship at any time, and to find the direction and distance of any place to which it may be required that the ship should be taken.

A curve passing through any two places on the earth, and cutting every intervening meridian at the same angle, is called a *rhumb line*; the angle which such a curve makes with each meridian is called the *course* between any two places through which the curve passes; and the arc of that curve intercepted between any two places is called their *nautical distance.* This distance is more than that measured on the arc of a great circle passing through the two places, unless both places are on the same meridian, or both on the equator, when the rhumb line and great circle coincide.

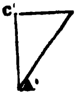
The *difference of latitude* between any two places is an arc of a meridian intercepted between the parallels of latitude on which the places are situated; and the *difference of longitude* is the arc of the equator, or the angle at the pole included between the meridians of the places. Hence, when the latitudes or the longitudes of two places are of the same denomination with respect to *north* or *south*, *east* or *west*, the difference is found by subtracting the less from the greater; but when of different denominations, what is called their difference is found by taking their sum. [LATITUDE; LONGITUDE.]

When a ship has sailed on a rhumb line from one meridian to another, the arc of the parallel at which the ship has arrived, intercepted between the two meridians, is called the *meridian distance* which the ship has made; and the sum of all the intermediate meridian distances, computed on the supposition that the distance sailed on the rhumb line is divided into indefinitely small equal parts, is called the *departure.*

In the annexed diagram, let P represent the north pole; D E an arc of the equator; P D, P F, P G, and P E meridians, and A B a rhumb line passing through A and B; A S, K H, L I, and B C, arcs of parallels of latitude at the points A, H, I, and B respectively; and let A H, H I, I B, &c. be so small and so numerous that neither they nor A K, K H, H O, I O, &c. may differ sensibly from straight lines. Then if a ship sail from A to B, B C is called the meridian distance; if from B to A, A S is called the meridian distance; and in either case the sum of K H, O I, N B, is called the *departure*; and A K + O H + I N, &c., which is always equal to A C or B S, is the *difference* of latitude.



Now. A K H, O H I, N I B, &c., may be considered as right-angled plane triangles; and if in the annexed plane triangle, right-angled at C′, A′B′ be taken equal to A B in the preceding figure, A′ C′ to A C, or to its equal A K + H O + I N, and the angle B′ A′ C′ to B A C, or O H I, or N I B, then C′ B′ in this figure would accurately represent K H + O I + N B, &c. in the preceding one. That is, in the plane triangle A′ B′ C′, right-angled at C′, if A′ represent the course from one place to another, A′ B′ the distance of the two places measured on the rhumb line passing through them; then A′ C′ will be their *difference of latitude*, and C′ B′ the *departure* made in sailing from the one to the other.



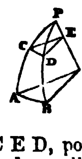
On these principles depends what is called *plane sailing*; and it is evident that if any two of the four elements, *course, distance, difference of latitude*, and *departure*, be given, the others may be found by the solution of a right-angled plane triangle. The formulæ are:

$$\left.\begin{array}{l}\text{dep.} = \text{dist.} \times \sin \text{course}, \\ \text{diff. lat.} = \text{dist.} \times \cos \text{course}, \\ \text{dist.} = \text{dep.} \times \operatorname{cosec} \text{course}, \\ \text{dist.} = \text{diff. lat.} \times \sec \text{course}, \\ \tan \text{course} = \dfrac{\text{dep.}}{\text{diff. lat.}}.\end{array}\right\} \quad (A)$$

When a ship sails on a meridian, the diff. lat. is the same as the nautical distance, and the *latitude* only, not the longitude, is changed; and when a ship sails on a parallel of latitude, the departure is the same as the nautical distance, and the *longitude* only, not the latitude, is changed: but it is evident that in sailing in any other direction both the latitude and longitude are changed.

For finding the change of latitude corresponding to any course and distance, the principles of plane sailing, already explained, are sufficient; but to find the change of longitude corresponding to any given change of place, considerations of a different kind are needed.

Let a ship sail on a parallel of latitude, as from C to D, and let P C A, P D B, be two meridians passing through C and D, and meeting the equator in A and B; then A B, or the angle A P B, is the difference of longitude, corresponding to the distance C D sailed on the parallel in the latitude A C or D B. And if F be the centre of the sphere, A F B, C E D, portions of the planes of the equator and parallel respectively, we have, by similar sectors,



$$\frac{AB}{CD} = \frac{BF}{DE} = \frac{FD}{DE} = \operatorname{cosec} PD = \sec BD = \sec \text{lat.}$$

$$\text{or } AB = CD \sec \text{lat.}$$

i.e. difference of longitude = distance × sec lat.

Hence, again, if in the annexed plane triangle M N O, right-angled at N, the angle M be made equal to the number of degrees and minutes of the latitude of the parallel on which the ship is sailing, and M N be equal to C D, M O in this figure will be equal to the arc A B in the preceding one, and will

consequently represent the difference of longitude; for

$$\text{M O} = \text{M N} \sec \text{M} = \text{C D} \sec \text{lat.}$$

Therefore, in sailing on a parallel, the properties which connect the latitude of the parallel, the distance sailed upon it, and the corresponding diff. long. are all found in a right-angled plane triangle; the base representing the distance sailed on the parallel, the hypothenuse the diff. long., and the included angle the latitude of the parallel.

When a ship sails on an oblique rhumb, two methods have been proposed for connecting the other elements with the diff. long.: one called the *middle latitude* method; and the other, from the name of its inventor, *Mercator's sailing*.

Middle latitude sailing is a compound of plane and parallel sailing. Referring to the first figure in this article, it is evident that K H is greater than C M, but less than A Q; that O I is greater than M N, but less than Q R; and that K H + O I + N B will not differ greatly from the meridian distance midway between the parallels C B and A S.

The departure corresponding to course c, and distance d, being therefore found from dep. $= d \sin c$, and this being taken as a meridian distance in the latitude $\frac{1}{2}(l + l')$, the middle latitude between the latitude l sailed from and l' arrived at, the diff. long. is found approximately from the principles of parallel sailing, from the formula,

$$\text{diff. long.} = \text{dep.} \sec \tfrac{1}{2}(l + l').$$

From this, and from the first and last of the formulæ (A), we immediately deduce the following for middle latitude sailing, viz.:—

$$\text{diff. long.} = \frac{\text{dist.} \times \sin \text{ course}}{\cos \text{ mid. lat.}}$$

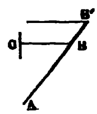
$$\tan \text{course} = \frac{\text{diff. long.} \times \cos \text{ mid. lat.}}{\text{diff. lat.}} \qquad \text{(B)}$$

$$\text{dep.} = \text{diff. long.} \times \cos \text{ mid. lat.}$$

In *Mercator's sailing*, the globe is conceived to be extended from the equator towards the poles, so as to form a cylinder whose diameter is that of the equator; the corresponding elementary parts of the meridians and parallels, as projected on the cylindric surface, bearing the same proportion to each other with the like corresponding parts on the spherical surface; the projected rhumb lines being straight lines, and the poles vanishing in infinite distance. Such a cylinder, unrolled on a plane, is called a *Mercator's chart*. Now, considering the earth as a sphere, the meridians and the equator are equal great circles, and therefore any small portion of a parallel is to a like portion of the meridian in the same proportion as the radius of the parallel to the radius of the equator; and therefore the elementary portion of the meridian divided by the corresponding portion of the parallel will be equal to the secant of the latitude. If, therefore, m represent the length of an elementary portion of the meridian at latitude l, and m' be the projection of m on Mercator's chart, then, generally, $m' = m \sec l$.

It follows from this that in Mercator's projection the degrees of latitude, which at the equator are equal to those of longitude, increase with the distance of the parallel from the equator proportionally to the secants of the latitudes. The parts of the meridian thus increased are called *meridional parts*; and it is a property of the projection that the meridional parts of any given latitude are equal to the sum of the secants of the minutes in that latitude. [MERCATOR'S CHART.] The sum of the secants being computed for every minute up to any latitude, l, and tabulated, forms what is called a table of *meridional parts*; and the difference, or the sum of the meridional parts corresponding to the latitudes of any two places, is called the meridional diff. lat. of those places, the *difference* being taken when the latitudes are of the *same*, and the *sum* when of *different*, denominations.

It is likewise a remarkable property of Mercator's projection, that any triangle on the sphere is represented on the chart by a similar triangle, the angles of the original triangle and its representation being equal. Hence the ship's path on the sphere and its projection on the chart cut the meridians under the same angle. If, therefore, A B C be a triangle on the sphere, A C being a portion of the meridian, and A B' C' its projection; then A B' and A C' will be in the same direction with A B and A C, and B' C' will be parallel to B C. In these triangles, therefore, the course A is an angle common to both; A C is the diff. lat., A C' the meridional diff. lat., C B the departure, C' B' the diff. long., A B the distance run, and A B' the distance as projected on the chart, the same scale being used for measuring all the lines in the diagram. Hence, from such parts of these triangles as may be determined by observation, or taken from tables, the others may be computed by the common rules of plane trigonometry.



The following formulæ are obvious consequences of this construction:—

$$\text{diff. long.} = \frac{\text{dep.} \times \text{mer. diff. lat.}}{\text{diff. lat.}}$$

$$\tan \text{course} = \frac{\text{diff. long.}}{\text{mer. diff. lat.}} \qquad \text{(C)}$$

$$\text{distance} = \text{diff. lat.} \times \sec \text{course.}$$

The course of a ship at sea is determined by the *compass*. [COMPASS.] The needle generally rests in a position pointing northerly and southerly; and the angle which its direction makes with the true north and south line is called the *variation of the compass*, the variation being denominated *easterly* or *westerly*, accordingly as the north end of the needle is to the east or west of the true north.

The amount of this deviation differs greatly in different situations; and it is by no means a constant quantity even at the same place. There are, however, simple astronomical means of finding it at any place; so that, by applying a correction for the variation, either the true course may be gained from an observed compass one, or the compass course from a computed true one.

Besides the general *variation* to which we have here adverted, it is found that in ships which have large masses of iron on board, or which are themselves constructed of iron, the compass is sensibly attracted, and the effect varies with the direction of the ship's head. The effect on the compass for different positions of the ship's head is discovered by swinging the ship and noting the difference of reading off between a compass placed on shore beyond the influence of the iron, and that of the compass on board. [DEVIATION OF THE COMPASS.]

The velocity of the ship, or the *rate* of sailing, is determined experimentally, at the end of every hour, by heaving the *log*. [LOG.] For changes of velocity between the times of heaving the log, the officer on duty makes the best estimate he can.

When the wind is adverse or changeable, it is often requisite to sail on different courses; and the crooked line which the ship then describes is called a *traverse*. The method of finding a single course and distance equivalent to such a compound one is called *resolving a traverse*.

This may be done by a geometrical projection, but it is generally effected in practice by the aid of the traverse table. From this table the *diff. lat.* and *dep.* corresponding to each course and distance is taken, and entered in an appropriate table, having columns headed N. S. E. W.; namely, N. and S. for diff. lat., and E. and W. for departure. The difference between the sums under N. and S. shows the diff. lat., as does the difference between the sums under E. and W. the departure; and in either case the difference is of the same denomination as the larger sum. The course and distance required are then either found by inspection in a traverse table, or by the formulæ (A).

When a ship makes considerable way through the water, and the wind is on the beam, abaft it, or even a little before it, she generally moves forward in the direction of the fore and aft line; but in rough weather, with the wind forward, she will generally be driven more or less to leeward, as will be shown by the direction of the wake, or the ripple formed by the waves closing behind her. The angle which this ripple makes with the direction of the keel is called the *leeway*; and it must be applied as a correction to the course shown by the compass, and always allowed *from* the wind—that is, to the left, if the wind is on the right-hand side of the ship, and to the right, if on the left. [LEEWAY.]

All matters relating to the navigation of a ship are entered in a systematically ruled book, called the *log-book*; and that which day after day is so recorded is called the ship's journal. The principal columns in the log-book are for the hour of the day, the course, rate of sailing, leeway, and winds; one for general remarks, and for entering the particulars and results of celestial observations, for notes on the weather, and memoranda as to all important points of duty in the ship, the sails set, and the manner in which the crew are employed. To this is daily appended the latitude and longitude of the ship at noon, both as deduced from celestial observations, and as computed from the course and distance since the time when the place was last ascertained. The place determined from the course and distance is called the place by *dead reckoning*. The bearing and distance of the land first expected to be seen, and the course and distance made on the whole, during the day, are also added.

If the course and distance could always be accurately determined, the place of the ship could be computed with corresponding exactness from the principles of which we have above given a concise account. But these data can only be obtained in a roughly approximative form. The effect of unknown currents, unavoidable imperfections in steering, and numberless other sources of error, render the place of the ship, as estimated from the reckoning, very doubtful; and, in fact, when the mariner is obliged to rely for several days on these data only, he often finds that his expected and his true place are considerably distant from each other.

In the modern practice of navigation, therefore, the course and distance are only used to enable the seaman to assign approximately the place of his ship between the times at which it is determined, independently, by celestial observations.

This branch of nautical knowledge, which is generally and properly included in every system of navigation, is called *nautical astronomy*; and the improvements which have been introduced in its modern application constitute the chief difference between navigation as practised in our own and former times.

For a minute explanation of the processes by which the place of a ship on the wide ocean may be determined, from the observed situation of celestial objects with respect to each other and to the horizon, we must refer to works expressly devoted to the subject. But we shall give a short account of the most useful practical methods of finding the *latitude*, the *longitude*, and the *variation of the compass*, which are the three principal problems in nautical astronomy.

Reduction of Altitudes.—Before the altitudes of celestial objects as observed at sea can be employed in the solution of astronomical problems, they must be corrected for the effects of dip and parallax; and for semidiameter, when the altitude of the upper or lower border, instead of that of the central, has been observed, as in the case of the sun or moon.

If A = the altitude of the upper or lower border, s = the semidiameter, d the dip of the horizon (that is, the angle through which the sea horizon appears depressed in consequence of the elevation of the observer), r the refraction corresponding to the alt. A, and p the horizontal parallax taken from the *Nautical Almanac* for the time of observation, and A' = the true altitude: then

$$A' = A - d \mp s + p \cos (A - d \mp s) - r.$$

In practice, the corrections to be applied to A to obtain A′ are taken from tables, and the process of reduction is short and simple.

To find the latitude from the observed meridian altitude of a known celestial object:

Let z be the complement of the true altitude as deduced from the observed one, D the object's declination, and L the latitude; and call z north when the zenith is north, and south when it is south of the object: then $L = z \pm D$; a formula in which D is + when z and D are of the same, and − when of different denominations, and L is of the same denomination as the greater of z and D.

To find the latitude from two observed altitudes of the sun, with the time elapsed between the observation:

Let t = the half elapsed time in degrees, p the sun's polar distance at the middle instant between the observations, s = half the sum, and d = half the difference of the two corrected altitudes; then compute the angles A, B, C, D, and E, in succession, from the following formulæ:—

$$\sin A = \sin t \,.\, \sin p.$$
$$\cos B = \sec A \,.\, \cos p.$$
$$\sin C = \operatorname{cosec} A \,.\, \cos s \,.\, \sin d.$$
$$\cos D = \sin A \,.\, \sin s \,.\, \cos d \,.\, \sec C.$$
$$E = B \mp D.$$

And the expression for the latitude is,

$$\sin \text{lat.} = \cos D \,.\, \cos E.$$

There are many other methods by which the latitude may be found, but the two which we have given are those most generally used by seamen.

We pass on to a consideration of the principles on which the methods of finding the longitude astronomically at sea are founded.

The longitude is found by comparing the *time* at the first meridian with the *time of the same denomination* at the place of observation, allowing 15° of longitude for every hour in the *difference* of the times.

In the annexed diagram, let P A represent the meridian passing over the first point of *Aries*, P S that passing over the true and P M that passing over the place of the mean sun, and P X that passing over any other celestial object X. Let also P G be the meridian of Greenwich, P N a meridian in *west* longitude, and P O a meridian in *east* longitude.

Then for that instant of absolute time, A P G represents the *sidereal*, S P G the *apparent*, and M P G the *mean* time at Greenwich; twenty-four hours of time being represented by four right angles. A P N, S P N, and M P N, are the sidereal, apparent, and mean time at the meridian P N; and A P O, S P O, and M P O, the like times at the meridian P O.

Now N P G, the longitude of the meridian P N, = A P G − A P N = S P G − S P N = M P G − M P N; and G P O, the longitude of P O, = A P O − A P G = S P O − S P G = M P O − M P G.

Therefore, the longitude of any place represented in time is equal to the difference of the relative times at the first meridian and the meridian of the place; the times being both sidereal, both apparent, or both mean time, and both reckoned from the same noon—*west* when the Greenwich time is *greater*, and *east* when it is *less* than the time at the place of observation.

The angle X P G, reckoned westerly from P G, is called the meridian distance of the object X from the meridian P G, and X P N its meridian distance from the meridian P N. A P X is its right ascension, A P S the right ascension of the sun, and S P M the *equation of time*, or the difference between mean and apparent time.

Now, if a be the altitude of an object X, as observed in a given latitude l, say on the meridian P N, and p = P X its polar distance; then, if we put $s = \frac{1}{2}(a + l + p)$, the angle X P N may be determined from this expression, $\sin^2 \frac{1}{2} (\text{X P N}) = \sqrt{[\sin (s - a) \,.\, \cos s \,.\, \sec l \,.\, \operatorname{cosec} p]}$. And X P N + A P X − A P S ± S P M = M P N, the mean time at the meridian P N.

P X, A P X, A P S, and S P M, are furnished by the *Nautical Almanac*; and it is evident, therefore, that from an observed altitude of a celestial object, with the data supplied by the *Nautical Almanac*, the *mean time* at the place of observation may be found.

With respect to the corresponding Greenwich time, it may be found by means of a chronometer, whose error and rate are ascertained before it is taken to sea. For example, if on May 4 the chronometer be 4m. fast for Greenwich time, and on May 14, 4m. 50s. fast for Greenwich time; then, if on May 30, at sea, an altitude be observed to determine time at the place of observation, when this chronometer shows 5h. 46m. 12s., then the true mean time at Greenwich is 5h. 40m. 2s.; and if the mean time at the place deduced from the observation be 3h. 57m. 48s., the longitude of the place will be 5h. 40m 2s. − 3h. 57m. 48s. = 1h. 42m. 14s. = 25° 33′ 30″ *west*.

The Greenwich time may also be found by considering the moon in the heavens as the pointer of a Greenwich clock, and her distances from the sun and certain stars as indicating the Greenwich times to which they correspond. These distances are computed, and published beforehand in the *Nautical Almanac*, for every third hour of Greenwich time; so that if at any moment we ascertain the moon's distance from some such celestial object, the Greenwich

time may be found by comparing that distance with those in the *Nautical Almanac*.

The distances there given, however, are the distances of the objects as seen from the centre of the earth; and therefore before a distance observed on the surface can be made available for finding the Greenwich time, it must be reduced to what it would have been if the observation had been made at the centre. Many formulæ have been devised, and numerous and extensive collections of tables have been formed, to assist the observer in making this reduction; but perhaps the following is as convenient as any that has been proposed.

Let z be the true zenith distance of the moon; z_1 the sun's or star's; a the apparent altitude of the moon; a_1 the sun's or star's; d the apparent distance of the centres of the two bodies, and D the true distance of the centres required; then D can be readily found from the following expression:

$$\text{vers } D = \text{vers } (z+z_1) + \text{vers } (d+A) + \text{vers } (d-A) + \text{vers } (a+a_1+A) + \text{vers } (a+a_1-A),$$

$$\text{where } \cos A = \frac{\sin z, \sin z_1}{2\cos a, \cos a_1}$$

The value of A has been calculated for different altitudes, and forms the table called *the table of the auxiliary angle A*, to be found in Inman's and other Nautical Tables. (See Jeans' *Navigation* for the construction of this table, and for other methods of clearing the lunar distance.)

To compute the bearing of the sun, the altitude, polar distance, and latitude being known: Let a = the altitude, l = the latitude, p = the polar distance, $S = \frac{1}{2}(a+l+p)$, and B the required bearing, or azimuth—estimated from the south when the latitude is north, and from the north when the latitude is south; towards the east when the altitude is increasing, and towards the west when it is decreasing, then

$$\sin \tfrac{1}{2} B = \sqrt{[\sec a \,.\, \sec l \,.\, \cos S \,.\, \cos (S-p)]}.$$

If the compass bearing of the object be observed when the altitude is taken, the variation of the compass may hence be found; for let B′ = the compass bearing; then the variation is B + B′ or B − B′, the sign + being used when one bearing is eastward and the other westward, and − when both are on the same side of the meridian; and the variation is *west* when B is to the *left*, and eastward when it is to the right of B′.

For an account of the history of navigation, the reader is referred to the Introduction to Robertson's *Elements of Navigation*. Of modern works on this subject in general use among British seamen, we may notice those by Dr. Inman, Mr. Jeans, and Mr. Riddle, treating both of the theory and practice. The Epitomes of Lieut. Raper, Mackay, and Norie are also very useful compilations, and have long had an extensive circulation.

Navigation Laws. In Economical History, the enactments made for the purpose of securing a monopoly of the carrying trade to home shippers, either by an absolute prohibition on goods imported in foreign bottoms, or by differential duties levied on such goods. Navigation laws have also been enacted in order to regulate the right of coast and deep-sea fishing, the coasts having generally been allotted to fishermen of the country, and importation from deep-sea fisheries having been limited to such vessels as have been built in the United Kingdom, and manned by British crews.

Regulations and statutes of this character are traceable in the earliest history of English commerce, though in consequence of the connection of a considerable part of the French seaboard with this country during the era of the Norman and Plantagenet kings, the restrictions put on maritime intercourse were not very severe, and as a consequence rates of transit were low, and supplies, especially of French produce, were abundant. The origin of the modern navigation laws is to be found in the foreign policy of this country, and the hostility felt towards the Dutch in the seventeenth century.

Foreigners had been excluded from the fisheries and coasting trade by 5 Eliz. In 1650, the Republican parliament prohibited all ships built or manned in foreign ports from traffic with the American plantations, unless a license were first obtained. This measure, one rather of police than of exclusion, was followed in the next year by the famous Act of Navigation. The provisions of this Act were partly intended to secure a monopoly of European traffic, partly to promote shipping interests, and to create and sustain a large seafaring population, partly to injure the opulence, and especially the maritime supremacy of the Dutch, who had about this time well-nigh engrossed the carrying trade of the world. All produce of Asia, Africa, and America, was excluded from England, Ireland, and the colonial dependencies, except it were imported in English ships, manned by an English master and (for the most part) by an English crew. Nor could any European produce be imported, except in English ships, or in ships which were the real property of the people in whose country the exported commodity was produced, or from which alone it could be exported. It was this last clause which was intended to cripple the trade of the Dutch, whose wealth was almost entirely derived from the profits of the carrying trade. On the Restoration, the navigation law was immediately re-enacted, and till a recent period was the basis of the commercial relations entered into between this and foreign countries. So strongly impressed were the people of the time with the wisdom of the Navigation Act, that they considered it a provision second only in its beneficial effects to the great charter, calling it the *Charta Maritima*. Two years later, the Act was extended so as to apply to Germany. Certain goods, it is true, were allowed to be imported in ships of any kind or origin; but a long list of specified articles, containing the

chief kinds of bulky and raw produce, were rigorously limited to English carriers. In effect the statute was intended to prohibit commercial intercourse with a large portion of the mercantile world, and as far as this country could bring such a result about, to exclude the Dutch and Germans from the pale of trade; and though some of the regulations in the Acts of 12 & 14 Ch. II. were relaxed, the leading provisions were retained up to the late changes in the law.

The policy of the navigation laws was the object of general praise. Even Adam Smith, though he fully recognised that any limitation of the means by which the market is supplied would enhance the cost of foreign produce, and diminish the price of exported goods, and therefore would check the power of buying as cheaply and selling as dearly as possible, does not scruple to say, that 'national animosity' suggested 'regulations as wise as could have been dictated by the most deliberate wisdom.' He does not indeed argue this, as some have argued it, on the ground that the existence of British commerce depended upon the provisions of the navigation laws; but, accepting the impression that the Act provided a nursery for seamanship, and acknowledging that defence is more important than opulence, he was prepared to sacrifice cheapness in one direction in order to secure safety in another. It is very doubtful, however, whether any such results were effected by the navigation laws, or whether any such compensation has been afforded.

It does not seem that the Dutch trade was weakened by the navigation laws, or the naval superiority of the Republic diminished. It remained powerful at sea for at least a century after this Act was passed; and the decline of its commercial superiority was due to other causes than the restrictive policy of this and other communities. It is generally, but we think erroneously, assigned to the pressure of taxation on the industrial resources of the Republic. It is more naturally interpreted by the unwise regulations which were taken by the Dutch in order to maintain the price of tropical produce, and by the weakness of a community which owed its commercial greatness to no permanent advantages of position on the highways of commerce, but to the precarious distinction implied in the qualities of intelligence, activity, and thriftiness. Holland occupied its commercial position chiefly, we believe, because other nations possessed of far larger natural capacities were late in discovering and adopting those principles and practices on which mercantile prosperity depends. It was eminent because it had as yet no rival, but its precedence was lost as soon as ever it was disputed by nations of equal energy and wider resources.

Nor does it appear that the naval superiority of this country depended in the least degree on the passing and continuance of the Navigation Act. England had begun to be formidable at sea before the protective system implied in this Act was elaborated. Drake and Hawkins and Frobisher were the true fathers of the English navy, and were bred up in the hardy school of free enterprise. Blake owed his maritime skill to other causes than the fostering care of the navigation law, and the naval pride of the Dutch was humbled before the law was enacted, and revived during the early years of its existence. Van Tromp was defeated when the highway of nations was free, and the Dutch burnt the English fleet in the Medway and insulted London when those provisions in which Adam Smith recognised the most deliberate wisdom were in force. As Mr. M'Culloch has very pertinently observed, 'Navigation and naval power are the children not the parents, the effect not the cause of commerce. If the latter be increased, the increase of the former will follow as a matter of course.' Shipping is no exception to the general rule, that protected interests never thrive.

The indirect effects of our navigation laws were exceedingly mischievous, and ultimately led to a system of retaliation which would, if it had not been met by timely concessions, have seriously endangered our commerce. The Americans in 1817 copied the very words of our own Act, and prepared to carry out its provisions in their own country, avowedly in order to compensate the restrictions which our laws had put upon their trade. The northern European powers threatened the same policy, and would certainly have carried their measures into execution, had it not been for the changes introduced into our maritime code by Messrs. Wallace and Huskisson. These changes contained important alterations in the rules by which trade with the British colonies from foreign ports was governed. At present, the last step in the direction of freedom having been taken in the year 1850, the trade between the colonies and the rest of the world is completely unshackled.

Pending the entire abolition of the navigation laws (with the exception of such parts of them as refer to the coasting trade, which still remains subject to certain conditions, chiefly with the view to obviate smuggling), a concession was adopted called the reciprocity system. This had its origin in the retaliatory measures of the United States, who levied a differential duty of nearly a dollar a ton on all produce imported in foreign ships beyond that paid by American vessels. To meet this regulation, various inoperative duties were attempted and abandoned. Ultimately, by the commercial treaty of 1815, it was agreed between this country and the United States, that equal charges should be imposed on ships of either country in the ports of the other, and that equal duties should be imposed upon all articles. Similar regulations were laid upon commercial intercourse with the South American states. In 1825, in order to meet similar retaliatory measures on the part of European communities, the reciprocity system was extended to the whole world, the administration

of the Act being left, as far as its details go, to the Privy Council. This doctrine of reciprocity is also retained in the Act of 1850, with this difference, that no rule exists that a foreign country must accept the provisions of the Act previous to its being entitled to participate in its advantages. If it appears to the council that any prohibition, restriction, or discriminating duty should be enforced, it may be ordered, subject, of course, to criticism in parliament.

Lastly, the distinction between British and foreign built ships is done away. To constitute a British ship, it is not now required that it should have been manufactured in any dock of the United Kingdom. It is to all intents and purposes British, if it be the property of British owners. Hence the English merchant may employ the building yard of any country, and is therefore enabled if he see fit to buy ships, as he may buy any other product, in the cheapest market. It was said at the time when this liberty was given, that foreign builders, owing to the greater cheapness of labour, would be able to undersell the home manufacturer, and some went so far as to predict the loss of the art of shipbuilding in England. But, as is often the case, the objectors did not define cheapness by its true test, efficiency; and the prophecy has been falsified by events. [SHIPPING.]

Navire (Fr.). An order of knighthood instituted by St. Louis, king of France, in 1269, to encourage the lords of France to undertake the expedition to the Holy Land. It derived its name either from the circumstance that the collars of the knights belonging to it had a ship pendent from them, or because the knights were allowed to bear in their arms a ship argent in chief.

Navy (Lat. navis, *a ship*). In its most extended signification this term is applied both to the mercantile and military marine of a nation; but it is more commonly restricted to vessels of *war* only, all others being said to belong to the merchant service. In treating of the navy, it is usual to consider it under two distinct heads, the matériel and personnel: the former comprising all that relates to the construction, armament, and equipment of ships; the latter including all who receive rank, pay, or emolument in the service of the navy, and including whatever concerns the appointment, station, and duties of officers, sailors, and marines. Under the different heads the reader will find a notice of the chief subjects included in the matériel of the navy.

The naval history of Great Britain is usually divided into three eras; the first comprising all the period that preceded the reign of Henry VIII.; the second ending with the restoration of Charles II.; and the third from the Restoration down to the present time. Omitting the English naval history between the Conquest and the reign of Henry VIII. as too unimportant to be dwelt upon in a sketch like the present, we may state, before passing to the second period, that the first monarch who maintained a naval force in time of peace was Henry VII., who also built the first line-of-battle ship of the British navy, in the third year of his reign. She was called 'The Great Harry,' had three masts, carried 80 guns (mostly, however, of trifling calibre), measured 138 feet in length, and 36 feet in breadth from outside to outside, and cost upwards of 14,000*l*. This ship constituted the most noble monument of the regard of Henry VII. for the navy; but his designs were matured by his son Henry VIII., in whose reign England may be said to have first possessed a regular and permanent navy. Before his reign our sovereigns had but few ships; and when they wished to transport an army to France, or to undertake any considerable naval enterprise, it was usually effected by requisitions of ships and seamen from the different seaport towns of the kingdom, or by hiring them from the merchants of Hamburg, Lubeck, Genoa, &c.; to be dismissed as soon as the occasion for their service was over. But Henry, whose naval force, as in the preceding reigns, was chiefly dependent on foreign auxiliaries, caused several 'shippes royall' to be constructed for the service of the state; among which were the 'Regent,' the 'Marie Rose,' and the celebrated 'Henri Grâce de Dieu,' of 72 guns, 700 men, and about 1,000 tons burthen. At the end of his reign in Jan. 1547, the verified list of the navy amounted to seventy-one ships and vessels of all sorts, measuring 11,268 tons. During the succeeding reign of Edward VI. and Mary, the naval force of England diminished considerably, and at the demise of the latter in 1558 amounted only to twenty-six vessels, measuring 7,110 tons burthen. During the long and prosperous reign of Elizabeth which ensued, the navy was greatly encouraged. The naval force collected to oppose the Armada, which consisted of 150 ships with nearly 30,000 men, amounted to 176 sail equipped with about 15,000 men; of these, thirty-four ships with 6,225 men, a larger royal armament than had ever before assembled together, belonged to the crown, the remainder being made up from London, Bristol, Yarmouth, the Cinque Ports, &c. During the last twenty-five years of Elizabeth's reign the navy almost doubled its number; and at her death, in 1603, it amounted to forty-two ships, measuring 17,055 tons, and carrying 8,346 seamen. The reign of James I. was remarkable for the first able and scientific naval architect, Phineas Pett, to whom the art of shipbuilding was indebted for many improvements, particularly in the diminution of top-hamper. 'In my own time,' says Raleigh, 'the shape of our English ships hath been greatly bettered; in extremity we carry our ordnance better than we were wont; we have added crosse-pillars in our royall shippes to strengthen them; we have given longer floares to our shippes than in olden times, and better bearing under water.' The striking of topmasts was also invented in this reign; and besides the improved shape of the vessels,

Raleigh mentions various minor improvements, adding, 'to the courses we have devised studdingsails, spritsails, and topsails; the weighing of the capstan is also new, and the chain-pump and bonnet; we have fallen into consideration of the length of cables, and by it we resist the malice of the greatest winds that can blow.' At the death of James I. in 1625, the royal navy consisted of thirty-three ships, measuring 19,400 tons. The navy was first divided into rates and classes under Charles I., who built several new ships in the beginning of his reign, and among others the 'Sovereign of the Seas,' a larger ship than had ever been built in England, carrying 100 guns, and measuring 1,637 tons. But in 1648 Prince Rupert carried off twenty-five ships, none of which ever returned to England; and so reduced was the navy at the commencement of Cromwell's government, that he could muster only fourteen men-of-war, some of them carrying only forty guns. But his vigorous administration speedily raised the navy to a magnitude and power formerly unknown; and under the command of Blake, it became not merely equal but superior to that of the Dutch, then the greatest maritime power of Europe. It was during the Protectorate that the ratings into which Charles I. had first divided the navy were clearly defined, and a regular system established, which has, with little alteration, remained in force down to the present time. At the death of Cromwell in 1658, the navy amounted to 157 ships, measuring 21,910 tons, and carrying 50,000 men.

At the restoration of Charles II. in 1660 (from which is dated the third period of British naval history), the whole fleet amounted to only sixty-five ships; but under the able administration of the duke of York, the royal fleet soon became a fine armament; and though the retirement of the latter (in consequence of his inability to take the Test Act), and the subsequent extravagance of the king, caused the navy to decay, yet such prompt and effective measures were afterwards taken by the duke, on his recall to office, for its restoration, that at the demise of Charles II. the navy amounted to 179 vessels, measuring 103,558 tons. During the foregoing reign, a remarkable change had taken place in scientific and mechanical operations, and the art of shipbuilding, so long practised on vague and imperfect principles, began to be more highly and extensively developed; for not only were the proportions and qualities of vessels improved, but the mind of the designer was directed to theoretical investigation; and thus the beginning of the third period of naval history marks the first application of science to naval architecture. It must, however, be remembered, that the science thus applied was essentially deductive. On his accession to the throne, James II. continued to evince the same warm interest which, as lord high admiral, he had always manifested for the welfare of the navy. He suspended the navy board, and appointed a new commission, with which he joined Sir Anthony Deane, the best naval architect of the time: four hundred thousand pounds were annually set apart for naval purposes; and so diligent were the commissioners in the discharge of their duty, that on the abdication of James, in 1688, the navy amounted to 173 sail, measuring 101,892 tons, and carrying 6,930 guns and 42,003 men. Under the administration of William and Mary, who made little alteration in the system adopted by their predecessor, 99 new ships were added to the fleet; and the celebrated engagement off Cape la Hogue, in 1692, gave the British navy its ascendency over that of France. Queen Anne at her accession found the navy to consist of 272 vessels, measuring 159,020 tons; but in the third year of her reign a most destructive storm visited this country and the adjacent coasts, by which the navy sustained great damage and loss. No fewer than ten men-of-war were totally lost, and many more were driven on shore and damaged. All measures adding to the strength and efficiency of the navy were exceedingly popular during this reign, and every plan compatible with financial economy was adopted for its benefit; so that though the number of ships was less at the end of Anne's reign, 1714, than at its commencement, the tonnage had increased 8,199 tons. During the first four years of George I. large sums were voted for the extraordinary repairs which were required after the long war. A general survey was made of the dockyards and sea-stores; new dimensions for several classes of ships were established; and at the death of this monarch, in 1727, the navy consisted of 233 ships, measuring 170,862 tons. The navy remained stationary for the first twelve years of the reign of George II.; but on hostilities breaking out with Spain, in 1739, it was considerably augmented, and a scale of increased dimensions was established in 1742. In the wars of 1744 and 1755, our naval enterprises were crowned with signal success; and at the demise of George II., in 1760, the navy consisted of 412 ships, measuring 321,104 tons, the vote for the naval service of that year being 5,611,508*l*., 51,645 seamen, and 18,355 marines. The unprecedented progress of the navy during the long reign of George III. is familiar to all. It may be sufficient, therefore, to observe, that though the combined fleets of France and Spain appeared to have an ascendency during the American war, the victories of Rodney restored British superiority. The nature of the struggle with revolutionary France, the bitterness with which it was carried on, and the fleets required not merely for the protection of our own shores, but for that of our mercantile shipping and of our numerous colonies in all parts of the world, led to an immense increase of our naval force; and while our navy was thus progressively augmented, the decisive victory of the 1st of June, 1794, followed by those of St. Vincent, Camperdown, the Nile, Copenhagen, and Trafalgar, almost destroyed every fleet

that could be opposed to it, leaving us undisputed masters of the ocean.

From the commencement of hostilities in 1793 to the peace in 1815, the British captured from their enemies 155 ships of the line and 586 smaller war vessels, while they lost (otherwise than by natural causes) 5 ships of the line and 151 smaller vessels of war.

Since the peace great reduction has been made in the number of royal ships, but the size of the individual vessels has been vastly augmented, the aggregate tonnage being now far in excess of that of 1815. The navy during this period has undergone three distinct reconstructions: first, by the substitution of larger ships; secondly, by the adoption of steam; and thirdly, by replacing wooden ships in a great degree by armour-plated vessels, almost invulnerable to shot, many of which have the peculiarity of reviving the ancient mode of warfare by being used as *rams*, the massive iron prows and powerful screw propellers constituting, however, a sensible difference from the beaked galleys of the ancients. Simultaneously the guns of the ships have been decreased in number, but enormously increased in power and range. On the whole, the power of a ship of war has so augmented within the last half-century, that it is probable that a heavy-armed iron-clad steam sloop of the present day could destroy a fleet of first-rates of the class known to Nelson, without receiving appreciable damage in return. To show how deceptive an estimate of the navy's force would be formed from a mere numerical return, the following statement of the progressive increase of the tonnage of ships of the most powerful class is alone necessary: In 1677 the largest vessel did not reach 1,600 tons; 1,800 tons had been attained in 1720; 2,000 tons by 1745; by the end of the American war there was a ship of 2,200 tons. In 1800, 2,500 tons was reached. Before the French war closed, there was a ship of 2,616 tons. For the Russian war we had a vessel of 4,000 tons; and now the largest iron-side—only a frigate, and carrying but 26 gigantic guns—counts 6,621 tons!

There is yet a moot question with regard to armour-plated ships themselves, which may perhaps in its ultimate results lead to further alteration. The great increase in the weight of artillery (the largest guns being now of the weight of 12 tons, exclusive of carriage) has led to the question whether it is practicable for a vessel to carry them as a broadside armament without unduly straining the keel and floors. Naval architects consider that ships, as now built, cannot; and, if they could, the management of such ponderous guns would be a matter of great difficulty. On the other hand, a ship can readily carry these or even heavier cannon amidships, as swivels. But as the protection of armour is now necessary, these swivels require shot-proof covering, for which purpose Captain Cowper Coles, R.N., has invented revolving iron turrets, centred on the keel, and made to revolve by machinery connected with the ship's engines. The bulwarks are made to fall down on hinges, and the masts are based on three diverging supports. These arrangements give t[illegible] range; and, viewed as a battery, there can be no question as to the advantage of the system. The Americans constructed, during the war of secession, numerous vessels on this plan; but they have not proved good sea-boats. The 'Royal Sovereign,' on the contrary, which was adapted in this country to Captain Coles' design, has held her own against the best of the other iron-clads in heavy sea-ways. The Admiralty still debate whether to try to make broadside-armoured vessels, which are known to be seaworthy, capable of carrying the heaviest ordnance, or to build seaworthy turret-vessels which can without doubt carry guns of the largest calibre.

It is a noteworthy circumstance, that of the new iron vessels, many of the finest have been built in private yards on the Thames, Tyne, Mersey, and Clyde.

The following table will show the force of the British navy at four distinct periods memorable in naval history:—

	Ships				
	Of the Line	Under the Line	Steamers	Grand Total	Tons
1793					
In Commission .	26	109	. .	135	
Ordinary . .	84	82	. .	166	
Building . .	12	8	. .	20	
Total . .	122	199	. .	321	402,555
1820					
In Commission .	14	113	. .	127	
Ordinary . .	113	255	. .	368	
Building . .	22	95	. .	117	
Total . .	149	464	. .	613	605,527
1830					
In Commission .	14	143	7	164	
Ordinary . .	75	262	4	341	
Building . .	18	64	1	83	
Total . .	107	469	12	588	544,416
1840					
In Commission .	28	149	65	242	
Ordinary . .	54	220	15	289	
Building . .	23	34	7	64	
Total . .	105	403	87	595	500,232

The present constitution of the navy so often excites political and professional discussion, that a greater detail is desirable. The following table shows the strength of the several classes of vessels composing the *steam* navy in 1865. For purposes of offensive war, these may be taken to represent our total effective force; for the wooden sailing vessels of the old type (of which many still exist), although useful as dépôts, hulks, and training ships, would be of little avail in line of battle, supposing that they could ever get there.

The Steam Navy of Great Britain, 1865.

Class of Vessel		No. of Vessels	Guns: Total	Guns: Largest	Guns: Smallest	Guns: Average	Tonnage: Total	Tonnage: Largest	Tonnage: Smallest	Tonnage: Average
Iron-cased Vessels:										
Screw-ships		26[a]	521	41	4	20	102,831	6,621	993	3,955
Hydraulic gun vessel		1[b]	2?	2	2	2	778	778	778	778
Double-screw gunboats		2[c]	4	2	2	2	1,491	754	737	745
Floating batteries (screw)		5	78	16	14	16	8,955	1,973	1,469	1,791
Ships:										
100 guns and upwards, screw		5	552	121	102	110	19,892	4,245	3,726	3,978
90 to 99 guns, screw		1	97	97	97	97	3,101	3,101	3,101	3,101
80 to 89 " "		12	983	86	81	82	41,578	3,729	3,091	3,465
70 to 79 " "		28	2,129	79	70	76	83,292	3,340	2,339	2,975
60 to 69 " "		17	1,086	68	60	64	40,894	2,642	1,751	2,406
50 to 59 " "		1	50	50	50	50	1,760	1,760	1,760	1,760
40 to 49 " "		1	49	49	49	49	3,771	3,771	3,771	3,771
30 to 39 " "		2	66	35	31	33	3,447	1,872	1,575	1,728
Frigates	Screw	38[d]	1,409	46	22	37	107,369	3,740	1,547	2,825
	Paddle	7	99	21	6	14	9,459	1,850	1,191	1,351
Corvettes	Screw	27	530	22	13	20	37,446	1,857	953	1,387
Sloops	Screw	37[e]	456	17	4	12	27,934	1,081	486	755
	Paddle	17	96	6	3	6	16,752	1,124	818	985
Gun Vessels	Screw	41[f]	181	6	1	4	22,691	859	299	553
	Paddle	1	3	3	3	3	237	237	237	237
Mortar Ships	Screw	3	36	12	12	12	3,549	1,258	1,090	1,183
Troop Ships	Screw	9	34	6	2	4	18,638	3,453	647	2,071
Store Vessels	Screw	6	10	4	0	2	4,855	1,131	440	726
	Paddle	1	1	1	1	1	704	704	704	704
Surveying Vessels	Screw	1	5	5	5	5	486	486	486	486
	Paddle	5	13	5	0	3	2,751	889	112	550
Despatch Vessels	Paddle	2	. .	. .	. .	. .	1,670	835	835	835
Tugs	Double-screw	1	. .	. .	. .	. .	37	37	37	37
	Paddle	11	1	1	0	0	2,528	360	76	230
Gunboats	Screw	119	160[g]	2	1	1	27,370[g]	270	209	230[g]
Floating Factories	Screw	2	. .	. .	. .	. .	1,263	720	543	631
Miscellaneous Small Vessels	Screw	1	. .	. .	. .	. .	295	295	295	295
	Paddle	35	61	6	0	2	12,734	889	111	364
	Screw and Paddle	1	. .	. .	. .	. .	42	42	42	42
Yachts	Screw	1	. .	. .	. .	. .	312	312	312	312
	Paddle	6	5	2	0	1	5,143	2,345	98	857
		473	8,717	121	0	18	615,555	6,621	37	1,301

[a] Of these 3 are returned as building.
[b] " 1 is " "
[c] " 2 are " "
[e] Of these 2 are returned as building.
[f] " 1 is " "
[g] An approximation."

The sailing navy, of little use except for harbour service, comprises 1 hospital ship, 4 receiving ships, 2 coal dépôts, 15 training ships (mounting 290 guns), 10 guard ships (carrying 306 guns), 3 store ships, 2 sloops, 2 brigs: all the foregoing being in commission. In addition to these there are 10 line-of-battle ships, 21 frigates, 6 corvettes, 13 sloops, and 19 brigs, cutters, and smaller vessels: all in ordinary. There are, at the same time, 115 old vessels, unfit for sea, on duty as coal-hulks, powder magazines, hospitals, tanks, churches, &c.

In the service of the coastguard are 48 fast-sailing cruisers and 38 watch-vessels, ranging in tonnage from 24 to 484 tons.

The parliamentary vote for the service of the navy in 1866 was 10,392,224*l.*

Classes and Rates.—It is of great importance, in order to insure union in the movements of a fleet and to facilitate the fitting out and repair of ships, that those of the same rate or class should not differ materially in size or build from each other. Until the Restoration vessels appear to have been 'rated' from the complement assigned to each, without any reference to the ordnance they carried; but on the recommendation of a committee appointed in 1745 this method was superseded by classification according to *guns*. In 1793 our ships, which, in consequence of the previous wars, had outgrown their establishments of ordnance, were rated anew at so many guns and upwards; but the latitude of the term *and upwards* giving rise to great irregularities, an investigation took place in 1816, when by an order in council the rule which existed previously to 1793 was revived, and ships were ordered to be rated thenceforth from the number of guns and carronades actually carried, and not according to the erroneous denominations which had latterly grown into use. Alterations have since been made from time to time, as the average size of the ships has increased. The royal navy, as at present constituted, comprises four principal classes: 1. Rated ships. 2. Sloops. 3. Gun vessels. 4. All other ships and smaller vessels commanded by lieutenants.

These classes of the royal fleet are thus subdivided:—1. Rated ships. *First rates*: ships carrying 110 guns and upwards, or having complements of at least 1,000 men. *Second rates*: one of the royal yachts, and all ships carrying from 81 to 109 guns, or having complements of from 800 to 999 men. *Third rates*: other royal yachts; all ships bearing the flag or pendant of an admiral superintendent or a captain superintendent of a dockyard; ships carrying 60 to 80 guns, or having complements of from 601 to 799 men. *Fourth rates*: frigate-built ships carrying from 410 to 600 men. *Fifth rates*: ships the complements of which are not more than 400 and not less than 300 men. *Sixth rates*: other ships bearing captains. The second class (sloops) includes all vessels placed in the charge of commanders, and carrying their principal armaments on one deck in broadside ports. The third class (gun vessels) comprises all vessels under commanders, and carrying their principal armament on one deck amidships. The fourth class, principally devoted to gunboats, is sufficiently described above.

Government of the Navy.—The general direction and control of all affairs connected with the navy is intrusted, under her majesty, to the lord high admiral, or to the commissioners for discharging the functions of that officer. The duties of the lord high admiral were formerly judicial as well as administrative; he having not merely to govern the navy, but to preside over a court for adjudging all nautical cases, and for taking cognisance of all offences committed on the high seas. But the judicial are now separated from the other duties of this high functionary, being devolved upon the judge of the Admiralty Court. [ADMIRALTY, COURT OF.]

From the reign of Queen Anne down to the present time, with the exception of the short period during which William IV., when duke of Clarence, held the office, the duties of the lord high admiral have been discharged by commissioners. These have consisted generally of a first lord and of four junior lords. Civilians may be appointed to these offices; but at least two of the lords are professional men. But though assisted by the advice of junior lords, practically all the power and authority of the board is vested in the first lord. The powers exercised by the Board of Admiralty are very extensive and important. They have the absolute control of the matériel and personnel of the navy, both as regards discipline and finance; subject, of course, to the votes of parliament and the annual Mutiny Act. The navy is represented in parliament by the first lord, who is a cabinet minister, by one civil lord and one of its secretaries, who are members of the government, and by any of the naval lords who may happen to be in the House.

Under the superintendence of the lords commissioners, the civil departments of the Admiralty are directed by a controller of the navy, an accountant-general, a storekeeper-general, a controller of victualling, a director-general of the medical department, a director of transports, a director of engineering and architectural works, an hydrographer, and a controller-general of the coastguard.

Passing to the active service, there are three gradations of admirals, viz. admirals, vice-admirals, and rear-admirals; distinguished by the mast at which they severally carry the St. George's flag, viz. at the main for an admiral, fore for a vice-admiral, and mizzen for a rear-admiral. All admirals, whatever be their rank, take the common title of *flag officers*. Admirals rank with generals in the army, vice-admirals with lieutenant-generals, and rear-admirals with major-generals.

The command of every rated ship is intrusted to a captain, who has under him a commander (if the ship be of the first, second, or third rate), a certain number of lieutenants, according to the size of the ship, with a master, paymaster, marine officers, surgeons, sub-lieutenants, engineers, midshipmen, gunners, &c. A captain of three years' standing ranks with a colonel in the army, and a captain of less than three years' standing, or a commander, with a lieutenant-colonel; a lieutenant of eight years' standing ranks with a major, and other lieutenants with captains; sub-lieutenants with lieutenants in the army, and midshipmen with ensigns. The captain is responsible for the discipline and efficiency of the crew, and the good order of the ship. But although he is furnished with minute instructions for his guidance in every particular, much must always necessarily depend on his conduct and character. He has power to order punishment to be inflicted; but his sentence must be carried out in the presence of all the officers and the ship's company. An account, stating all the circumstances, must also be entered in the ship's log, an abstract of which is forwarded each quarter to the Admiralty. This regulation has tended to repress hasty and inconsiderate punishment; and has done much to improve the conduct of the officers, as well as to promote the proper discipline of the navy.

Composition of the Navy.—The navy is composed of two bodies of men—seamen and marines [MARINES]; and the officers under whose command it is placed are divided into three classes, viz. commissioned, warrant, and petty officers. Commissioned officers comprise flag officers, commodores (who are acting flag officers), captains, commanders, lieutenants, staff commanders, masters, inspectors of machinery, chief engineers, sub-lieutenants, second masters, chaplains, naval instructors, medical officers, paymasters, secretaries to flag officers, assistant paymasters, and all officers of marines. Warrant officers are those who hold their appointment by warrant from the lords commissioners of the Admiralty; to this class belong gunners, boatswains, carpenters, and engineers. Petty officers are divided into three classes: chief, first class, and second class. It is unnecessary to specify the numerous com-

ponents of these classes, who comprise all the skilled artificers of the crew.

Any person may enter the navy as a common seaman, on application to the commanding officer of any of her majesty's ships in commission, provided he be approved by the examining surgeon, and have not previously been 'discharged from the service with disgrace.' Persons who have never been at sea are rated as ordinary seamen of the second class, and seafaring men are rated as *ordinary* or *able* seamen, according to their experience. [IMPRESSMENT.]

Young gentlemen enter the service as naval cadets between twelve and fourteen. The cadet must remain in the training ship a twelvemonth; he is then discharged into a sea-going ship as a cadet, unless he obtain a first-class certificate on passing out, in which case he will be discharged as a midshipman. If discharged as a cadet, he has to serve another twelvemonth in order to qualify for a midshipman. After serving as midshipman three years and a half, he is examined (provided he is nineteen years of age) in seamanship, and he then obtains the rank of acting sub-lieutenant, which rank is confirmed on his passing the examinations at the Naval College at Portsmouth.

No person is eligible for promotion to the rank of lieutenant till he has passed the above three examinations; but if a midshipman has passed in seamanship he may, by death or invaliding vacancy, be granted a commission as *acting* lieutenant, which is generally confirmed on his passing the final examination at Portsmouth.

Captains and admirals are promoted by seniority, on what is termed a *flag promotion* taking place; but a captain must have served as under, in command of a rated ship, before he can obtain his flag; viz.

In war	4 years.
In war and peace combined	5 „
In peace	6 „

All other classes of officers are promoted at the discretion of the Board of Admiralty, the patronage resting with the first lord. There is, however, an educational standard to which every officer must attain, prior to promotion or advancement. For other particulars relating to the navy, see NAVAL ARCHITECTURE, SHIP, and the other naval articles, which will be found under their respective heads in this work.

Foreign Navies.—Space forbids any lengthened description of foreign navies, and it must suffice to state that the marine of nearly every power has advanced greatly in efficiency during the past few years. There seems to be a contest between the powers which shall form the best fleet of iron-sided vessels. Nations little known in modern naval warfare are already acquiring these terrible floating fortresses. Italy, Turkey, Egypt, Sweden, Denmark, Spain, and Portugal have already several; while France, Russia, and the United States have fleets which the British government might not always find it easy to match. It is fair to add, that a large proportion of these foreign armour-plated vessels, as of those built for the British navy, have been constructed in the workshops of the Thames, Clyde, Mersey, and Tyne.

Nazarene. A native of Nazareth. This name is commonly applied in the East to Christians, as being the followers of Jesus of Nazareth. It also denotes a sect which sprang up in Palestine in the second century, and endeavoured to engraft the rites and observances of the Jews on the religion of Jesus Christ: in this respect they bore a considerable resemblance to the Ebionites, whose contemporaries they were, but with whom they must not be confounded. No traces of them existed in the fifth century.

Nazarite (Heb. nazar, *to separate*). In the Levitical law, one separated to the Lord by a vow. (Num. vi.) The chief observances of the Nazarites were, to refrain from drinking wine, to suffer the hair to grow, and to avoid coming in contact with a corpse.

Ne Exeat Regno (Lat.). In Law, a writ to detain a person from going out of the kingdom without the king's license, directed to the sheriff, or to the party himself. The use of the writ is to prevent a party from withdrawing his person and property from the jurisdiction of the courts in England; but this purpose was served at common law before the late Insolvent Act by arrest, and bail obtained. This writ lies, therefore, where there is a suit in equity for a demand for which the plaintiff could not arrest at law; and is always granted upon a bill just filed in equity.

Neap or Neep Tides. The lowest tides, being those which are produced when the attractions of the sun and moon on the waters of the ocean are exerted in directions perpendicular to each other. When the two forces act in the same or in exactly opposite directions, the *spring* or highest tides are produced. The neap tides take place about four or five days before the new and full moons. [TIDES.]

Neat (A.-Sax. nyten, from nitan = ne witan, *not to know*; corresponding to the Greek ἄλογον, as a name for an irrational animal: Wedgwood). A term applied to cattle: *neat's foot oil* is the fat obtained by boiling calves' feet.

Nebulæ (Lat. *clouds* or *mists*). In Astronomy, the name given, on account of their general cloudy appearance, to a very numerous class of celestial objects, being, however, for the most part, *telescopic*, and only visible in telescopes of considerable power.

It is to Sir William Herschel that astronomy is indebted for the first examination and analysis of these remarkable objects. A few of them have indeed been known since the discovery of the telescope, and one or two of them are visible to the naked eye; but his powerful telescopes first disclosed the fact of their existence in immense numbers, and in all quarters of the heavens, not indeed distri-

buted uniformly, but generally speaking with a marked preference to a broad zone, crossing the Milky Way nearly at right angles, its general direction being not very remote from that of the hour circle of 0h. and 12h. In the southern hemisphere the distribution appears to be more uniform.

Nebulæ are divided by Sir W. Herschel into the following classes: 1. Clusters of stars, in which the stars are clearly distinguishable; 2. Resolvable nebulæ, or such as excite a suspicion that they consist of stars, and which any increase of the optical power of the telescope might be expected to resolve into distinct stars; 3. Nebulæ, properly so called, in which there is no appearance whatever of stars; 4. Planetary nebulæ; 5. Stellar nebulæ; and 6. Nebulous stars.

Clusters of Stars.—These are either globular or of an irregular figure, forming bright isolated patches, which attract attention, as if they were brought together by some general cause. The Pleiades is a cluster of this sort: the naked eye can distinctly perceive six or seven stars in it, and may catch occasional glimpses of a great many more; but the telescope shows fifty or sixty crowded together in a very moderate space, and insulated from the rest of the heavens. A luminous spot, called *Præsepe*, or the Beehive, in the constellation Cancer, is resolved entirely into stars by an ordinary telescope. In the sword-handle of Perseus is another such spot, crowded with stars, but not so easily resolved. There are a great number of less distinct nebulous specks of the same kind, which in ordinary telescopes have much the appearance of comets without tails, and have frequently been mistaken for such: when, however, they are examined with instruments of great power, any such idea is completely destroyed. They are then, for the most part, perceived to consist entirely of stars, crowded together so as to occupy almost a definite outline, and to run up to a blaze of light in the centre, where their condensation is usually the greatest. Many of them are of an exactly round figure. Others, again, are of an irregular form, and less definite in their outline, so that it is not easy to say where they terminate. In some of them the stars are nearly all of a size, in others extremely different; and it is no uncommon thing to find a very red star occupying a conspicuous situation in the group.

Resolvable nebulæ are considered as objects of the same nature as the preceding; but as being either too remote, or consisting of stars too faint, to affect us by their individual light. They are almost universally round or oval; their irregularities of form being extinguished by the distance, and only the general figure of the condensed parts being discernible. In telescopes of insufficient optical power, all the great globular clusters exhibit themselves under this appearance.

Nebulæ, properly so called.—Observations with superior telescopes had rendered it probable that no physical distinction existed between this class of objects and clusters of stars, the difference of appearance seeming to depend only on the power of the telescope with which they were observed; but recent researches with the spectroscope applied to the telescope have completely negatived such an hypothesis. Although multitudes of nebulæ which in Herschel's eighteen-inch reflector exhibited not the slightest appearance of resolvability, when examined with Lord Rosse's six-foot reflector are clearly resolvable, and seem to consist merely of clustering stars, still many exist which, under the greatest powers which have been yet applied, show no signs of being composed of separate stars. The great nebula in the sword-handle of Orion, discovered by Huygens in 1656, and repeatedly figured and described by astronomers since that time, is a notable instance. Another in the constellation of Andromeda may be mentioned, which is visible to the naked eye, and often mistaken for a comet. Its appearance is described by Simon Marius as that of a candle shining through horn. Its form is a pretty long oval, increasing by insensible gradations of brightness, at first very gradually, but at last more rapidly, up to a central point, which, though very much brighter than the rest, is yet evidently not stellar, but only nebulous matter in a high state of condensation. It has in it a few small stars; but they are obviously casual. Mr. G. P. Bond describes it as extending nearly two and a half degrees in length, and upwards of a degree in breadth. Like the last described, a very numerous class of nebulæ are of a round or oval figure, increasing more or less in density towards the central point. In this respect, however, they differ extremely; in some the condensation being slight and gradual, in others great and sudden. They also present great diversity of appearance, in respect of deviation from the spherical form. Some are only slightly elliptic, others much extended in length; and in some the extension is so great as to give the nebula the character of a long, narrow, spindle-shaped ray, tapering away at both ends to points. Some nebulæ are annular; but these are among the rarest objects in the heavens. The most conspicuous is situated halfway between the stars β and γ Lyræ, and may be seen with a telescope of moderate power.

Planetary nebulæ have exactly the appearance of planets—round or slightly oval discs, in some instances quite sharply terminated, in others a little hazy at the borders, and of a light exactly equable, or only a little mottled, which, in some of them, approaches in vividness to that of actual planets. Whatever the nature of these objects may be, they must be of enormous magnitude. One in Aquarius presents the diameter of 20″; another, in Andromeda, has a visible disc of 12″, perfectly defined and round. Granting them to be equally distant from us with the stars, their real dimensions must be such as would fill, on the lowest computation, the whole orbit of Uranus. Their intrinsic splendour must also be immeasurably

inferior to that of the sun's: for a circular portion of the sun's disc, subtending an angle of 20″, would give a light equal to 100 *full moons*, whereas not one of the nebulæ in question is discernible with the naked eye. Lord Rosse has recently observed a marked spiral arrangement in several nebulæ.

Stellar nebulæ are those in which the condensation of the nebulous matter towards the centre is great and sudden; so sudden, indeed, as to present the appearance of a dull and blotted star, or a star with a slight burr round it. The *nebulous stars* present the beautiful and striking phenomenon of a sharp and brilliant star, surrounded by a perfectly circular disc or atmosphere of faint light: in some cases dying away on all sides by insensible gradations, in others almost suddenly terminated. A very fine example of such a star is 55 Andromedæ, R.A. 1h. 43m., N.P.D. 50° 7′.

'The nebulæ,' says Sir J. Herschel, 'furnish, in every point of view, an inexhaustible field of speculation and conjecture. That by far the largest of them consist of stars, there can be little doubt; and in the interminable range of system upon system, and firmament upon firmament, which we thus catch a glimpse of, the imagination is bewildered and lost. On the other hand, if it be true, as, to say the least, it seems extremely probable, that a phosphorescent or self-luminous matter also exists, disseminated through extensive regions of space, in the manner of a cloud or fog, now assuming capricious shapes, like actual clouds drifted by the wind, and now concentrating itself like a cometic atmosphere around particular stars, what, we naturally ask, is the nature and distinction of this nebulous matter? Is it absorbed by the stars in whose neighbourhood it is found, to furnish, by its condensation, their supply of light and heat? or is it progressively concentrating itself, by the effect of its own gravity, into masses, and so laying the foundations of new sidereal systems, or insulated stars? It is easier to propound such questions than to offer any probable reply to them.' ('Treatise on Astronomy,' *Cabinet Cyclopædia*. See also Herschel's *Outlines of Astronomy*.)

The recent researches of Mr. Huggins have proved that many of the unresolvable nebulæ consist, chiefly at least, of glowing gaseous matter; nitrogen and hydrogen being apparently their principal constituents. This highly important discovery entirely alters the ideas previously entertained respecting the nature of such nebulæ. The opinions which have been entertained of the enormous distances of the nebulæ, founded upon the supposed remoteness at which stars would cease to be separately visible in our telescopes, must now be abandoned, in reference at least to those of the nebulæ which have thus been proved to be gaseous. If we suppose the gaseous substance of these objects to represent the *nebulous fluid* out of which, according to Herschel's hypothesis, stars are to be elaborated by subsidence and condensation, we should expect a gaseous spectrum with groups of bright lines as numerous as the dark lines, due to absorption, found in the spectra of the stars. We cannot, however, conceive that the elementary gases composing these nebulæ can ever condense into solids and liquids such as we find in our own solar system.

Necessity, Doctrine of. That scheme which represents all human actions and feelings as links in a chain of causation, determined by laws in every respect analogous to those by which the physical universe is governed. This doctrine has been attacked and defended with great zeal, in almost every period of speculative enquiry since the Reformation. The inductive method of research, applied by Bacon and his contemporaries to the phenomena of nature, led very soon to the adoption of a similar method in reference to the phenomena of mind. The discovery, or rather the distinct reassertion, of the law of association, by Hobbes, and the ready solution which it appeared to furnish of states of consciousness, which, without it, would have seemed capricious and unaccountable, encouraged many philosophers to attempt its application to every province of the human mind. It is only in connection with this fact that the prevalence of necessarian views in modern times can be adequately explained. The distinction between man and nature, between the actions of a self-conscious agent and the workings of blind unintelligent powers, was considered by the great philosophers of antiquity as the groundwork of their systems of morality, and as involved in the very conception of moral science. It was natural that this distinction should be felt to be a barrier to the progress of an exclusively empirical psychology. To the historians of man's nature the necessity of his actions appeared in the light of an hypothesis which lay at the very foundation of their enquiries, precisely as the natural philosopher is compelled to assume the regular recurrence of the same outward phenomena under the same circumstances. The psychologist considers the states of which he is conscious merely as they are related to each other in time; and, thus considered, it seems to him a mere identical proposition to assert that all that can be known of them is the order of their succession. If their succession were arbitrary or uncertain, nothing could be known of it, and the science which he professes could no longer have an existence. It is in this consideration, rather than in the dialectic subtleties by which the doctrine has been sometimes defended, that the real strength of the necessarian lies. So long as he can maintain the merely phenomenal character of human knowledge, he can reduce his opponents to the dilemma of either denying the possibility of mental science altogether, or of admitting the existence of those uniform laws which are its only object. In its relation to morality, the doctrine of necessity has been considered to involve dangerous consequences. Attempts have been made by modern neces-

sarians to rescue it from this imputation. Sir James Mackintosh, in particular, has devoted some portion of his Dissertation (*Encyclopædia Britannica*) to the explanation of the principal ethical terms, on the necessarian hypothesis. (*General Remarks*, sec. vii. p. 393.) Notwithstanding the ingenuity of this effort, the student will probably find, on careful examination, that the great question at issue is left much in the same state as before.

Neck of a Capital. In Architecture, the space above the shaft of a column, between the annulet of the capital above, and the astragal at the top of the shaft below. In Mediæval Architecture, the mouldings at the bottom of the capital of a column are frequently called the neck mouldings.

Necrology (Gr. νεκρός, *dead*, and λόγος). A collection of biographical notices of deceased persons, published shortly after their death, is commonly called a necrology. The list of deceased benefactors to a monastery, cathedral, &c., was also termed its necrology.

Necromancy (Gr. νεκρομαντεία). Divination by consulting the spirits of the dead. The Necyomanteia of the *Odyssey* exhibits the superstition in a very peculiar form. Odysseus (Ulysses) performs a sacrifice with peculiar solemnities, and pours the sacrificial blood into a ditch; the spectres of the dead rush wildly from the infernal regions to taste the blood; when, discovering the shade of Teiresias, of which he was in search, he compels it to answer his questions. The rest of the book, in which Odysseus appears actually to descend to the shades, and to see the punishments of celebrated criminals, is suspected by some commentators to have been an interpolation of later times. Similar customs in practising the art of necromancy seem to have been followed for a long period in Greece and Italy. Horace mentions the pouring of the blood of a sacrificed sheep into a ditch in order to attract the Manes from beneath. But in Thessaly, the most celebrated of classical regions for its proficiency in the art of magic, peculiar horrors seem to have attended the exercise of necromancy. Erichtho, Lucan's Thessalian witch, reanimates the corpse of a soldier slain in battle, and compels him to answer her questions respecting futurity. But the ψυχάγωγοι, or professed evokers of spirits, in Thessaly, seem to have performed their rites, whether as impostors or as fanatics, with the sacrifices of human beings and various other enormities. [Magic; Witch.]

Necronite. A variety of Orthoclase. It is found in small nodules in the limestone of Baltimore, and when struck it exhales a fetid odour resembling that of putrid flesh.

Necrophagans (Gr. νεκρός, and φάγω, *I eat*). The name of a family of Clavicorn beetles, comprehending those which feed on dead and decomposing animal substances.

Necropolis. Literally, *a city of the dead*, or a common graveyard for interring the bodies of deceased persons. The burying-places of the ancient Egyptians were often divided into places of interment for the separate castes in the same enclosure. One of the most singular of these structures may be seen at Isa-el-Haghar in Lower Egypt: it is a parallelogram of 2,160 French feet on the side, by 1,440 feet, and contains several rows of tombs. Amongst the Greeks, the custom appears to have prevailed of using the ancient quarries for this purpose, as at Nauplia, and near many cities of Asia Minor also. The necropolis of the Greek cities was always removed from the habitations of the living; and no one was buried in the cities, but as an exception. For the Etruscan tombs, see Dennis, *Cities and Cemeteries of Etruria*.

Necrosis (Gr. νέκρωσις). In Botany, a disease of plants, chiefly found upon the leaves and soft parenchymatous parts of vegetables. It consists of small black spots, below which the substance of the plant decays; and hence is commonly called *spotting*.

Necrosis. This term is applied in Surgery to the mortification of parts of bones.

Nectar (Gr.). In Greek Mythology, the drink of the immortal gods. [Ambrosia.]

Nectarine. A variety of the peach, in which the velvety covering of the skin is obliterated, and the surface is smooth and shining. Nectarines are generally more highly flavoured than peaches.

Nectarium. In Botany, the nectary of a flower, that is to say, any part that secretes a honey-like substance. The term is variously applied to modifications of the petals, of the stamens, and of the disc.

Needle Ore (so called from the acicular form of its crystals). A native sulphide of bismuth, copper and lead, found at Beresowsk in Siberia, embedded in white Quartz. It occurs in acicular four or six sided prisms.

Needle Stone. The name given to acicular varieties of Natrolite and Scolecite.

Negative (from Lat. nego, *I deny*). In Logic, this term denotes the quality of a proposition which denies the agreement between the subject and predicate.

Negative Sign. In Algebra, this term denotes an operative symbol written thus, $-$: it is also called *minus*, and combines with other symbols according to predetermined rules. The fundamental operative laws of algebra remaining the same, the results will bear different interpretations, or admit of no intelligible interpretation whatever, according to the greater or less generality of the meanings ascribed to the symbols. Thus in the first generalisation of ordinary arithmetic, where letters are used as symbols of numbers, the negative sign denotes subtraction, and a result $a-b$ is perfectly intelligible so long as a exceeds b, but simply unintelligible when b exceeds a. In the latter case, of which $3-5$ may serve as an illustration, the general laws of algebra permit us to write the result in any one of the forms $(5-2)-5$, $5-5-2$, $0-2$, -2; in which last form the result in question is called a *negative number*. When, more generally, we operate

upon symbols of quantity, a result such as $-a$ is called a *negative quantity*, and may always be considered as a quantity of the same *nature* as a, but diametrically opposite in *kind*; thus if a represent distance measured *northwards*, $-a$ will denote the same distance measured *southwards*; if a denoted a sum of money *gained*, $-a$ would denote an equal amount lost; or again, if a represented *future* time, $-a$ would denote *past* time, and so on.

The doctrine of negative quantities involves many metaphysical subtleties, and has given rise to numerous discussions; amongst the most instructive works on the subject are the following: Carnot's *Géométrie de Position*, Paris 1803; Peacock's *Algebra*, Cambridge 1830, and his 'Report on certain Branches of Analysis,' *Proceedings of the British Association* 1834; De Morgan's *Trigonometry*, London 1849, and his art. in the *Penny Cyclopædia*; Sir W. R. Hamilton's *Lectures on Quaternions*, Dublin 1853, and his 'Essay on Conjugate Functions, &c.' in *Transactions of the Royal Irish Academy* 1835.

Negotiable Instruments. In Law, instruments on which the right of action passes by mere assignment, signified ordinarily by indorsements, of which the chief are bills of exchange and promissory notes. To render them legally negotiable, it appears that the words *payable to bearer* or *to order*, or equivalents for these, must be employed.

Negro (Span.; Lat. niger, *black*). This term has been applied to the dark races of men distributed over the tropical and southern districts of Africa, and found also in the Papuan, Australian, and Tasmanian islands. Latham has defined a negro as an intertropical African in 'a humid alluvial locality.' The skulls of negroes exhibit a more or less prognathism or protrusion of the maxillary alveoli, and diagonal position of the teeth. The hair is crisp and woolly, and the calf of the leg fleshless; the feet are large and flat, whilst the pelvis is contracted. The outer surface of the brain of negroes exhibits a more symmetrical arrangement of the gyri than is usual in Europeans; it is not known whether this difference extends to the internal cerebral structure. The large size of the true molar teeth and the junction of the frontal and squamosal bones are also frequent characters of the negro races.

The distinctions of this race are marked and peculiar; but they are not universal or everywhere the same. Thus, the colour varies, although less so, perhaps, than that of any other of the great varieties of mankind; the Hottentots, and various southern tribes belonging to the Ethiopian race, are in this and other respects widely different from their brethren. The woolly hair, dark jet colour, and some external peculiarities of conformation, seem chiefly to belong to those numerous tribes which inhabit the west coast of Africa, between the equator and the tropic of Cancer. But, even within that region, some tribes are to be found whose physiognomy is very different from that which we are accustomed to regard as representing the negro type. South of the equator many of the tribes are inferior in strength and stature, and very different in appearance: from this region many of the Brazilian negroes are imported. In New Guinea, off the south-eastern extremity of Asia, a native population is found with most of the characteristics of the African negro.

The negro race appears to have been subjected to the tribute of furnishing slaves to its more powerful and intelligent neighbours from a very remote period. Many ages before the first European slave ship had visited the coasts of Africa, the Arabs bore off slaves in their caravans, across the Sahara, to the northern coasts of the continent; and even in classical writers (Terence, for example) we find mention made of black or Ethiopian slaves. [Slave Trade.]

By the mixture of the negro and white races the mulatto is produced; the Zambo is the offspring of a negro and an American Indian. The numerous varieties of these mixed races, according to the proportion of negro, European, or Indian blood in each, are classed and denominated accurately in the West Indies. It may probably be estimated that there are now on the continent and islands of America, including negroes and mulattoes, but excluding those mixed races which have a larger proportion of European blood, about ten million individuals of African descent; viz.

In the United States	3,500,000
British colonies	900,000
Hayti	700,000
Spanish, French, &c. West Indies	1,200,000
Brazil	2,500,000
The free states of continental America, formerly Spanish colonies	1,000,000
	9,800,000

Of these many are still in a state of slavery; the remainder, except in Hayti, forming an inferior and generally an oppressed class of free inhabitants. The ultimate destiny of this multitude of human beings is a matter of anxious speculation. Hayti, peopled by the slaves of the French colony of St. Domingo, who threw off the yoke at the period of the French revolution, is the only region in which they have as yet established an independent community; and the progress of that community in civilisation is not such as to raise the hopes of the philanthropist.

The existence of the distinguishing features of the negro race in a strongly marked degree is uniformly associated with the lowest state of barbarism; and as they recede from this strongly marked type, we find a greater degree of civilisation and improvement. The inevitable conclusion is, that every variety of the negro type, which comprises the inhabitants of almost all Central Africa, is indicative of mental inferiority; and that ferocity and stupidity are

the characteristics of those tribes in which the peculiar negro features are found most developed.

But without drawing any conclusions as to their inferiority merely from their configuration and appearance, it may be remarked that while most of the European and Asiatic nations have attained to a high state of civilisation, they continue, with few exceptions, in nearly primeval barbarism. It is scarcely enough to reply that this is the result of the unfavourable circumstances under which they have been placed. An intelligent enterprising people will contend against unfavourable circumstances, and make them become favourable; but the Africans, with the questionable exception of the ancient inhabitants of the valley of the Nile, have never displayed any considerable degree of enterprise or invention.

For an able summary of the physical and mental characters, as well as the history of the negro races, see Campbell's *Negromania*, 8vo. Philadelphia 1855; Pruner Bey's *Mémoire sur les Nègres*, 8vo. Paris 1861.

Negundo. A genus of *Aceraceæ* comprising an ornamental hardy tree of small stature, sometimes introduced with good effect into shrubberies. A variegated-leaved variety, in which the leaves are very conspicuously marked with white, is one of the most attractive of deciduous trees, if well placed in planting. The only species is called *N. fraxinifolium*.

Nehallenia. The name of an ancient Dutch and Flemish divinity who presided over commerce and navigation. Her origin and general character are unknown, and even the name suggests only forced and unsatisfactory associations; the sixteen altars bearing her image and name found in the island of Walcheren in 1647 are taken as evidence of her former influence. (Grimm's *Deutsche Mythologie.*)

Neil's Parabola. [PARABOLA; SEMICUBICAL.]

Neith. An Egyptian deity, who was regarded as an incarnation of nature, and as the patroness of all the arts. Her most celebrated temple was at Sais, where stood the famous veiled image.

Nelumbiaceæ (Nelumbium, one of the genera). In Botany, the name of a natural order of aquatic plants of great beauty, belonging to the Nymphal alliance, distinguished principally by its distinct carpels and large honeycombed torus. The only genus is *Nelumbium*, which comprises two or three very handsome species. One of them, *N. speciosum*, is believed to be the Sacred Lotus, or Pythagorean Bean. The nuts of all the species are wholesome and edible, and the rootstock is also sometimes eaten.

Nem. Con. A contraction for (Lat.) *nemine contradicente*, signifying no one contradicting; *nem. diss.*, contracted for (Lat.) *nemine dissentiente*, signifies no one dissenting.

Nemalite (Gr. νέμος, *wood*; λίθος, *stone*). A fibrous variety of Brucite.

Nematoideans (Gr. νηματώδης, *filiform*). The name of an order of *Cœlelmintha*, or cavitary intestinal worms, comprehending those which are diœcious, and have a round, filiform, elongated body.

Nematoneura (Gr. νῆμα, and νεῦρον, *nerve*). A name proposed for that division of the *Radiata* of Cuvier, including animals in which nervous filaments are distinctly traceable, and the alimentary canal floats loosely in a distinct abdominal cavity.

Nemean Games. One of the four great national festivals of Greece, in which all the states participated. [GAMES.] They were celebrated at Nemea, a village in the north-eastern part of Argolis. By some they are said to have been established by the Epigoni, children of the warriors who besieged Thebes; but other versions of the myth relate that they were first instituted by Hercules after his victory over the Nemean lion. They were held every third year, under the presidency of citizens chosen by lot from the states of Argos, Corinth, and Cleonæ. The games were the same as those of Olympia. The victorious combatants were crowned with parsley.

Nemesis (Gr. *distribution*). This word, which in the *Iliad* is used only to express any cause of anger or righteous indignation, becomes in the Hesiodic *Theogony* the name of a daughter of Nyx, the night (or, according to another version, of Erebus). Starting with the notion of mere apportionment whether of good or evil, the idea of the goddess assumed afterwards a harsh and forbidding character, and she became especially the punisher of those on whom Fortune, τύχη, had bestowed her favours too lavishly. This idea of Nemesis suggests a comparison with the later notions of ATÊ, and ERINYS. Nemesis had a celebrated temple at Rhamnus in Attica; and her earlier statues are said to have resembled those of Aphroditê. She is generally represented as a virgin deity; but there was a legend that from an egg born of Nemesis sprang Helen and the Dioscuri, Castor and Polydeukes. [POLLUX.]

Nemocera (Gr. νῆμα, *a thread*, and κέρας, *horn*). The name of a family of Dipterous insects, including those which have long filiform antennæ.

Nemoglossata (Gr. νῆμα, and γλῶσσα, *a tongue*). The name of a tribe of Hymenopterous insects, including those which have a long filiform tongue, as the bee tribe.

Nemophila (a name coined from Gr. νέμος, *a grove*, and φιλέω, *I love*). A genus of beautiful annual flowers very popular amongst amateur gardeners, from their free-flowering habit and brilliant colours. It belongs to the order *Hydrophyllaceæ*, and in *N. insignis*, which has blue flowers with a white centre, yields perhaps one of the gayest of flower-garden ornaments.

Neocomian. The rocks of the lower division of the Cretaceous period, including part of the Wealden, bear this name on the continent of Europe. They form an extensive and important series of deposits in the neighbourhood

of Neufchâtel in Switzerland. There are two divisions. The Lower Neocomian represents the greater part of the Lower Greensand and some Upper Wealden beds. The Upper Neocomian is the uppermost division of the Lower Greensand much more largely developed than in England.

The Neocomian beds in Switzerland and elsewhere on the Continent are well supplied with characteristic fossils, which agree on the whole with those of the corresponding beds in England.

Neocorus (Gr. νεωκόρος, literally *a temple sweeper*). In Grecian Antiquities, the title of officers employed as guardians of temples and their treasures.

Neolite (Gr. νέος, *new*, and λίθος, *stone*). A massive variety of Talc in which part of the silica is replaced by alumina. It is found at the Aslak iron mines, near Arendal in Norway.

Neologism (Gr. νέος, and λόγος). The introduction of a new phrase or word into a language, or any innovation on ordinary modes of expression. Most European tongues have their classical diction fixed by precedent and authority; and words introduced by bold or careless writers, since this standard was established, go by the name of neologisms until usage has added them at last to the received national vocabulary.

Neology. In the last century, this name was given by orthodox divines in Germany to the novel system of interpretation which then began to be applied by many to the records of the Old and New Testaments. [RATIONALIST.]

Neomenia (Gr. *the time of the new moon*). The name given by the Greeks to the beginning of the month of the lunar calendar.

Neophyte (Gr. νεόφυτος, *newly planted*). In the primitive church, newly converted Christians were so termed; and the same appellation is still given in the Roman church, to converts made by missionaries among the heathen, to any person entering on the priestly office, and to those persons newly received into the communion of the church.

Neoplase (Gr. νέος, *new*; πλάσις, *formation*). A native sulphate of iron found at Fahlun, in Sweden. [BOTRYOGENE.]

Neoplatonists. In Ancient Literature, the mystical philosophers of the school of Ammonius Saccas and Plotinus are commonly so called, who mixed some tenets of ancient Platonism with others derived from a variety of sources, and particularly from the demonology of the East. They flourished in the fourth and fifth centuries of the Christian era. Some, however, have contended that this title is more properly applicable to the eclectic Platonists, or school of Antiochus and Philo. [PLATONISTS; ECLECTICS.] For a singular view of the doctrines and tendency of the Neoplatonists, the reader may consult the *Quarterly Review*, July 1840.

Neotokite (Gr. νέος; τόκος, *a birth*). An amorphous mineral of a black or brownish-black colour found at Gäsböle in Finland. It is, probably, an altered form of Rhodonite, produced by the weathering of other minerals.

Neotype (Gr. νέος, and τύπος, *a form*). A variety of Natrocalcite containing Barytes.

Nepenthaceæ (Nepenthes, one of the genera). A natural order of subshrubby climbing plants referred by Lindley to his Euphorbial alliance, and distinguished by some technical points in the structure of the seeds. They are, however, to be recognised with ease and certainty by their external characters. The leaves, for instance, are more or less elongated, and their midrib is extended beyond the apex in the form of a tendril, which in the perfect condition of the plant supports a pitcher-like body provided with a jointed lid. They afford some of the most curious objects to be met with amongst plants. *Nepenthes* is the only genus, but there are many species known, several of which are to be found in the hothouses of the curious.

Nepenthe (Gr. νηπενθής, *removing sorrow*). A magic potion, mentioned by the Greeks and Romans, which was supposed to obliterate pain and sorrow from the memory of those who partook of it. The mixture given under this name by Helen to the guests of Menelaus is said to have been obtained from the Egyptian Thebes; hence the term *Thebaic tincture*, applied to tincture of opium, or laudanum. The word is now used figuratively to express any remedy which gives rest and consolation to an afflicted mind.

Nepeta (Ital. nepatella, *cat-mint*). The genus of the Catmint, a common wayside weed of the labiate order, particularly attractive to cats. This catmint is *N. cataria*, sometimes called Nep.

Nephalia (Gr. νηφάλιοι, *sober*). Certain Grecian sacrifices in honour of various deities, so called because no wine was offered during their celebration.

Nephelê (Gr. νεφέλη, *a cloud*). In Greek Mythology, the wife of Athamas, and mother of PHRIXUS and HELLÊ, who are thus literally the children of the mist.

Nepheline (Gr. νεφέλη). A double silicate of alumina and soda found at Capo di Bove, near Rome, and on Monte Somma, near Vesuvius, in fine white crystals lining cavities in the older lavas, with Idocrase, Mica, Hornblende, &c. Transparent fragments immersed in nitric acid assume a clouded appearance (whence the name). It is also known by the name of *Sommite*.

Nephelium (Gr. νεφέλη). This genus, which belongs to the order *Sapindaceæ*, contains three celebrated exotic fruits, the Litchi or Leechee of China, the Longan of China, and the Rambutan of Malaya. The Litchi produces nearly round fruit, an inch and a half in diameter, containing a sweet jelly-like pulp; the Longan is smaller, and possesses an agreeable subacid flavour; and the Rambutan, which is of an oblong form and about two inches long, is esteemed for its pleasant acidulous

pulp. All these are small trees with pinnated leaves.

Nephralgia (Gr. νεφρός, *the kidney*; ἄλγος, *pain*). Pain in the kidney.

Nephrite (Gr. νεφρός). A hard tough mineral occurring in compact masses of a leek-green colour, passing into grey and greenish-white, on the western coast of New Zealand. The name more commonly given to Nephrite is Jade, of which there are two kinds: White or Oriental Jade; and Green Jade, the Jadéite of Damour. Both these varieties are silicates of alumina, and of other bases, as lime, magnesia, soda, protoxide of iron, &c., and both are only broken, or cut and polished, with great difficulty. Oriental Jade is the well-known material of a pale greenish-white colour, which is brought to this country from the eastern parts of Asia, carved into various articles with a beautiful polish, a manufacture for which the Chinese are very celebrated. Green Jade is more rare than the Oriental kind, and valuable in proportion. The colour, which varies from apple-green (like that of Chrysoprase) to a sort of emerald-green, is probably due to oxide of nickel. The name Nephrite probably originated in the circumstance of small plates of the mineral having been formerly worn suspended from the neck for the cure of diseases of the kidneys.

Nephritis (Gr. from νεφρός). Inflammation of the kidney. This disease is attended by pain in the affected part, extending along the ureter, and increased on walking, or in the upright posture: nausea and vomiting are common attendants, and the appearance of the urine is generally far from healthy. Bleeding, warm baths, sudorifics, and aperients, with opiates and diluents, are the principal remedies resorted to.

Nephrodium (Gr. νεφρός, and εἶδος, *likeness*). A genus of Ferns, closely allied to *Lastrea*, belonging like it to the Aspidiaceous group, and like it also having the sori covered by reniform indusia; but in *Nephrodium* the veins of the pinnule-like segments anastomose in a connivent manner with those of adjoining segments for a greater or less distance from the rachis of the pinna, as the segments are more or less united. They are for the most part tropical plants.

Nephrotomy (Gr. νεφρός; τέμνω, *I cut*). The operation of extracting a stone from the kidney.

Nepidæ. [Hydrocorisæ.]

Nepotism (Lat. nepos). A word invented to express a peculiar characteristic of many high ecclesiastics in Roman Catholic countries, and more particularly of popes: a propensity, namely, to aggrandise their family by exorbitant grants and favours conferred on members of it; literally, on nephews (nepotes). Many of the highest and wealthiest families of the Roman nobility owe their elevation entirely to this species of patronage.

Neptune (Lat. Neptunus). In Astronomy, the planet of our system the most distant from the sun. The existence of this planet was predicted, and its place in the heavens announced within one degree of the truth, independently by two astronomers—Professor Adams and M. Leverrier—before it was discovered by the telescope. This triumph of mathematical skill marks an epoch in astronomy and sets a seal on the theory of universal gravitation which formed the basis of the method of prediction. Its existence was first suspected in consequence of irregularities in the movement of the planet Uranus, which baffled all attempts to attribute them to perturbation caused by known bodies. As far back as 1841 Mr. Adams determined to investigate the problem, and by September 1846 the new planet had fairly been grappled. On July 29 in that year the equatorial of the Cambridge Observatory was first employed in the search after the planet, the probable place having been stated by Mr. Adams. M. Leverrier, who had been working independently at the same problem, published his researches on August 31; and in a letter to the Berlin astronomers, which reached them on September 23, he assigned the place where he expected it would be found. This place was not one degree from that assigned to it by Mr. Adams. On the same evening, thanks to the Berlin star maps, which had not reached England, the planet was discovered.

As Neptune's nearest approach to us is 190,000,000 miles, it is invisible to the naked eye. Its diameter is 4·72 greater than that of the earth. Its revolution round the sun is accomplished in 60126·72 days. Neptune is accompanied by a satellite, the distance of which from the primary is nearly equal to that of our moon—225,000 miles; it accomplishes its revolution in 5 days 21 hours 8 minutes. Of the physical constitution of the planet we know nothing except its mass and density; these, as compared with the mass and density of the earth, are 18·900 and 0·321 respectively.

Neptune. In Mythology. [Poseidon.]

Neptunian. A name formerly given to a school of geologists which taught (with Werner) that all the great deposits and accumulations of rock had taken place in the presence of water, and from solution or suspension in water. That a very large proportion of all rocks have been so formed, is now placed beyond a doubt by evidence derived from the fossils which they contain; and that many more, generally thought plutonic, have been originally formed in contact with water and with water as an essential element, is also certain. Still there is no doubt that certain rocks, such as lavas at present and basalts anciently, are distinctly igneous, and that many of the plutonic rocks have been formed at great depths, at high temperature and under enormous pressure, although probably not without the presence of liquid water. The discussions concerning the *Vulcanists* and *Neptunists* are now only interesting as connected with the early history of geology.

Nereidans. The name of the family of

dorsibranchiate Anellidans of which the genus *Nereis* is the type. The characters are, an even number of tentacula attached to the sides of the base of the head, and a little farther forwards two others which are biarticulate, between which are two simple ones. Their branchiæ consist of small laminæ, between which is spread a network of vessels; each foot is also furnished with two tubercles, two packets of bristles, one cirrus above and another beneath.

Nereides (Gr. Νηρηΐδες). The daughters of Nereus, and nymphs of the sea. They were originally conceived to be of a beautiful form, but later fictions degraded them to the idea of a mermaid. Among the most famous of these nymphs were Amphitrite, Galatea, Thetis, &c. [NYMPHS.]

Nereus (Gr.). A sea-god, son of Ocean and Earth, standing to Poseidon in the same relation in which Gæa stands to Dêmêtêr, or Helios to Phœbus.

Nerita (Lat., the name of a shell-fish in Pliny). This term was applied by Linnæus to a genus of his *Vermes Testacea*, characterised by having a shell with the columella in a straight line, which renders the aperture of a semicircular form: this aperture is always closed by an operculum. The genus is ranked by Cuvier amongst his Pectinibranchiate Gastropods, and is subdivided into the subgenera *Natica*, Lam., *Nerita*, *Voluta*, and *Neritina*, Lam. *Nerita* proper is a marine shell, while *Neritina* is an inhabitant of fresh waters. Examples of both genera are found fossil in the strata of the Paris basin.

Nerium (Gr. νηρός, *humid*). To this genus of *Apocynaceæ* belongs the well-known Oleander, a shrubby plant, with long willow-like leathery leaves, and terminal clusters of large rose-coloured flowers. It is very ornamental, but like many others of its order is furnished with a poisonous juice.

Neroli. The name given by perfumers to the essential oil of orange flowers. It is procured by distillation with water in the same way as the other volatile oils. The oil of the leaf of the orange-tree (*essence de petit grain*) is sometimes substituted for it.

Nervation. In Botany, the manner in which the veins of the leaves &c. are arranged.

Nerves (Lat. nervus, Gr. νεῦρον). In Botany, the ribs or principal veins of the leaf.

Nervous Fever. This term was formerly used to indicate a condition now recognised as a variety in typhoid fever, in which nervous symptoms, or sensorial debility, are especially prominent. The treatment consists in allaying irritation and supporting the strength.

Nervous System. In Physiology. The nerves are fibrous chords in direct or indirect connection with the brain, and extending their ramifications into every part of the body. Their ultimate structure is filamentous, and they consist of a peculiar grey substance, their size depending upon the number of filaments enclosed in the common sheath. They are often so interwoven as to form a kind of network or *plexus*; and some of them have what are termed *ganglia*, or rounded masses of nervous matter, not fibrous, but apparently composed of globules disseminated through a vascular network.

There are two distinct systems of nerves; one of which is connected with the brain and with the spinal chord. These, being media of sensation and of voluntary motion, are termed the nerves of *animal life*, or the *cerebro-spinal* nerves. The other system is in communication with the brain and spinal chord, or with the cerebro-spinal nerves, only by very small filaments, and they have numerous ganglions throughout their course; they preside over the nutritive functions, upon which the mind has no direct influence: these are the nerves of *organic life*, or *ganglionic* or great *sympathetic* nerves.

The cerebro-spinal nerves convey impressions from their extremities to the brain, and they also convey the influence of the will from the brain to the voluntary muscles; these passing and repassing, or receptive and emissive, influences, are conveyed by distinct sets of nervous filaments, which, however, are generally enclosed in the same sheath, and therefore appear to form a single nerve: the terms *centripetal* and *centrifugal* filaments have been distinctively applied to them.

The history of the nervous system in all its details forms an extended and complicated, but a highly important part of anatomy and physiology, and the investigations connected with them have led to many useful practical results, which, however, have thrown but little light upon the cause of the phenomena, or the ultimate nature of the nervous influence. The works of Sir Charles Bell, Dr. Marshall Hall, and Dr. Wilson Philip must be consulted in reference to the functions of the different classes of nerves; there is a good general account of the subject in Baly's translation of Müller's *Physiologie*.

NERVOUS SYSTEM. In Comparative Anatomy. In some of the lowest-organised animals the nervous system has been detected in the form of simple filaments; these are afterwards found connected with a nervous ring surrounding the œsophagus. As organisation advances, nervous matter begins to be accumulated upon the ring, forming a brain; and upon different parts of the radiating filaments, forming ganglions.

When the principal gangliated filaments are not parallel, or not symmetrical in their course, they are associated with the type of organisation which characterises the molluscous or *heterogangliate* division of animals. When the gangliated filaments are two in number, symmetrical, and run parallel with each other along the ventral aspect of the body, they are associated with and bespeak the type of organisation characteristic of the articulate or homogangliate division. When the brain ceases to present the form of a ring, and sends down the back a prolongation of its sub-

stance, called the spinal marrow, the rest of its organisation is that which characterises the vertebrate or *myelencephalous* subkingdom, or primary division of animals. In the vertebrate and articulate animals the superficial tract of the spinal or ventral chords is *sensitive*, the deeper-seated tract *motive*.

Nervures. In Entomology, corneous tubes serving to expand the wing and keep it tense, as well as to afford protection to the air-vessels: they are termed costal, post-costal, mediastinal, externo-median, interno-median, anal, axillary, &c. according to their relative positions.

In Botany, *nervures* are the veins of leaves. [NERVES.]

Nesodon (Gr. νῆσος, *island*, and ὀδούς, *tooth*). A genus of fossil Toxodont Mammalia from the pliocene strata of Port St. Julian, Patagonia. The *Nesodon ovinus* was as large as a sheep; the *Nesodon imbricatus* the size of a llama.

Ness. The termination of several names of places in Great Britain where there is a headland or promontory, as Inverness, Sheerness. The word is probably akin to the Fr. nez, the Ger. nase, Lat. nasus, *nose*.

Nestorians. The followers of Nestorius, patriarch of Constantinople, in the first half of the fifth century. This prelate agitated the Christian world, after the Arian controversy had been settled, by the introduction of certain subtle disputations concerning the divine and human natures in Christ, between which he affected to distinguish with peculiar precision; and, in guarding against the propensity which he discovered in the Christians of his own day to confuse the two and look upon them as absorbed into one compound substance, he forbade men to entertain any combined notion at all, and kept constantly before their eyes both the God and the man. He insisted, for instance, that the Virgin should not be entitled *Mother of God*, but *Mother of Christ*, or of *Man*, the human nature being essentially distinct from and only inhabited by the divine, as a temple by its divinity. Nestorius was condemned by the third general council held at Ephesus, in the year 431: his principal adversary being the president of the assembly, Cyril, patriarch of Alexandria. After his deposition, he was banished by the emperor to an oasis in Upper Egypt, where he died. His opinions, however, spread throughout Asia, and appear to have been carried along, with the advancing stream of Christianity, to the farthest parts of India and China. In the more Western regions, they were soon afterwards counteracted by the spread of the opposite theories of Eutyches. [EUTYCHIANS; MONOPHYSITES; MONOTHELITES.] Besides the well-known authorities, the reader may consult Doucin, *Histoire du Nestorianisme*, 1698; Assemann's *Bibliothèque Orientalis*; Grant's *Residence among the Nestorian Christians*, 8vo. 1841; Milman's *Latin Christianity*, book ii. ch. iii. [THREE CHAPTERS.]

Nests, Esculent. A species of nests built by swallows, peculiar to the Indian islands, and much esteemed in China and other parts of the world. These nests resemble in form those of other swallows; they are formed of a viscid substance, and in external appearance as well as consistence are not unlike fibrate ill-concocted isinglass. Esculent nests are principally found in Java, in caverns usually situated on the sea-coast. Nothing satisfactory is known as to the substance of which these nests are composed. (*Commercial Dictionary*, art. 'Birds' Nests.')

Net (Ger. netz). A textile fabric of knotted meshes, for catching fish and other purposes. Each mesh should be so secured as to be incapable of enlargement or diminution. The French government offered in 1802 a prize of 10,000 francs to the person who should invent a machine for making nets upon automatic principles, and adjudged it to M. Buron, who presented his mechanical invention to the *Conservatoire des Arts et Métiers*. It does not appear, however, that this machine has accomplished the object in view; for no establishment was ever mounted to carry it into execution. Nets are usually made by the fishermen and their families during periods of leisure.

Net or **Neat** (Fr. net, from Lat. nitidus, *shining*: Wedgwood). In Commerce, something pure and unadulterated with any foreign mixture. Thus, wines are said to be *net* when not falsified; and coffee, rice, &c. to be so, when the filth and ordures are separated from them. The word *net* is also used for what remains after the tare has been taken out of any merchandise; i.e. when it is weighed clear of all package. [TARE.] *Net produce* (Ital. netto proceduto) is used in mercantile language to express what any commodity has yielded, after all tare and charges have been deducted.

Nethinims. Among the Jews, the servants of the priests and Levites, employed in the lowest and meanest offices about the temples. They are termed 'the hewers of wood and drawers of water for the house of God,' an office to which the descendants of the Gibeonites are stated to have been condemned by Joshua.

Nettings. Nets of small rope placed in a ship for various purposes, as stowage, or defence against accidents; also against boarding.

Nettle (A.-Sax. netele). The common name of the plants of the genus URTICA [which see], well known on account of their stinging property.

Nettlerash. An eruption upon the skin much resembling that produced by the sting of a nettle. It usually lasts for a few hours, and then disappears or changes its place; it is generally relieved by mild aperient medicines.

Neukirchite. A kind of Wad found at Neukirchen in Alsace, forming a coating on Red Hæmatite.

Neural Arch (Gr. νεῦρον, *a nerve*). In Anatomy, the arch of the vertebra or primary segment of the skeleton which protects a corresponding segment of the neural axis: it is posterior in man, superior in other vertebrates,

and is formed below by the *centrum*, laterally by the *neurapophyses*, and above by the *neural spine*.

Neural Axis. In Anatomy, the central trunk of the nervous system, consisting of brain and myelon: it is sometimes called *cerebro-spinal axis*.

Neuralgia (Gr. νεῦρον, and ἀλγός, *pain*). An acute painful affection in the course of the nerves. The forms of neuralgia most commonly met with are sciatica, lumbago, and tic douleureux. The two former receive their name from the nervous parts affected, viz. the sciatic and the lumbar nerves; the latter from the sudden and severe stroke of pain experienced. This latter affection frequently observes a curious periodicity: its usual seat is in the fifth nerve and its branches.

Neurapophysis (Gr. νεῦρον, and ἀπόφυσις, *a process*). In Anatomy, the autogenous vertebral element which forms the side or wall of the arch protecting the neural axis or central trunk of the nervous system: it has been called the *vertebral lamina*, and by Soemmerring the *radix arcus posterioris vertebræ*.

Neurility or **Neuricity** (Gr. νεῦρον). The property of the fibrous structure of the nerves.

Neurolite (Gr. νεῦρον, and λίθος, *stone*). A hydrated silicate of alumina and lime, with a fibrous structure, from Stamstead in Lower Canada.

Neurology (Gr. νεῦρον, and λόγος). The anatomy of the nervous system.

Neuropterans (Gr. νεῦρον, and πτερόν, *a feather*). The order of Tetrapterous Mandibulate insects, including those in which the nervures of the wings are so disposed as to form a more or less regular network. They are distinguished from the Coleopterous, Orthopterous, and Hemipterous orders of four-winged insects, by the first or anterior pair of wings being membranous, diaphanous, and resembling the second pair in texture and properties. The abdomen is unprovided with a sting. The antennæ are usually setaceous. Some neuropterans merely pass through a semi-metamorphosis, the rest a complete one; the larvæ have always six hooked feet. Many of these insects are carnivorous in their first state and their last. The dragon-fly may be regarded as the type of this order.

Neuroskeleton (Gr. νεῦρον, and σκελετός, *dried up*). The deep-seated bones, which are connected with the nervous axis and locomotion.

Neurotics. Remedies which act upon the system.

Neurotomy (Gr. νεῦρον, and τέμνω, *I cut*). The cutting of a nerve.

Neuter (Lat. *neither*). In Grammar, this term comprises those nouns which are neither masculine nor feminine. *Neuter* or *intransitive* verbs are those which represent the properties of a state or process, as *I rest, I fall, I grow*, &c. [GRAMMAR.]

Neuter was the name given to the *labourers* of the hive-bee, before it was discovered that they were essentially females, though infertile.

Neutral Equilibrium. [STABLE AND UNSTABLE.]

Neutral Salts. Combinations of acids and bases which are neither acid nor alkaline, but in which the acid is exactly *neutralised* by the base.

Neutrality. In International Law, the condition of a state which does not take part in a war between other states. A neutral nation has the right of furnishing to either of the contending parties all supplies which do not fall within the description of *contraband of war* [CONTRABAND OF WAR], and to conclude treaties with either unconnected with the subject of the war. It appears to have been the old principle, with regard to the maritime trade of a neutral nation, that the property of an owner belonging to the hostile country might be seized by a belligerent on board a neutral power's vessel; but the general rule now asserted is that the flag covers the cargo: by which means right of search, except for specific purposes, is rendered unnecessary. By the declaration of March 28, 1854, made on the occasion of the Russian war, England *waived* the right of seizing enemy's property on board a neutral vessel, unless contraband, but did not abandon it.

Neuvaines (Fr. from neuf, *nine*). In the Roman Catholic Church, prayers offered up for nine successive days, in order to obtain the favour of Heaven. (*Dict. de la Conversation.*)

New Connexion Methodists or **Kilhamites.** A society so called from Alexander Kilham, who was the immediate means of their separation from the Wesleyans, from which body they withdrew on the ground of the almost irresponsible power exercised by the Conference. Their number is not considerable.

New Red Sandstone. This name is given by geologists to a group of sandstones, generally of a red colour, belonging to the lowest and oldest division of the secondary period, and distinguished by fossil contents from some other important sandstones, also of a red colour, but in rocks below the carboniferous limestone. The latter are called OLD RED SANDSTONE [which see]. The series as developed in England consists chiefly of coloured sandstones and marls containing enormous quantities of salt, both rocksalt and saline springs, and much gypsum. It includes the upper and lower members of the TRIASSIC SERIES of the Continent, the MUSCHELKALK or shell limestone being absent. The sandstones are much used as building stone, and some of them near Liverpool and Warwick are remarkable as having upon them numerous footprints of animals, reptilians chiefly, but probably also birds. Except these footprints, fossils are rare in the new red sandstone in England, though many fragments of plants have been found from time to time, and some shells. In the Muschelkalk of the Continent there are many characteristic fossils.

New Style. In Chronology. [STYLE.]

New Testament. The name given to that portion of the Bible which comprises the

Gospels and the Apostolic Epistles, with the Apocalypse or Revelation of St. John. The four Gospels bear the names respectively of Matthew, Mark, Luke, and John. These are followed by the Acts of the Apostles, which have been attributed to St. Luke, and by twenty-one Epistles, of which fourteen have been ascribed to St. Paul, three to St. John, two to St. Peter, one to St. James, and one to St. Jude. [BIBLE; BIBLICAL HISTORY; EPISTLE.]

New Year's Day. The celebration of the commencement of the new year dates from high antiquity. The Jews regarded it as the anniversary of Adam's birthday, and celebrated it with splendid entertainments—a practice which they have continued down to the present time. The Romans also made this a holiday, and dedicated it to Janus with rich and numerous sacrifices; the newly elected magistrates entered upon their duties on this day; the people made each other presents of gilt dates, figs, and plums; and even the emperors received from their subjects new year's gifts, which at a later period it became compulsory to bestow. From the Romans the custom of making presents on New Year's Day was borrowed by the Christians, by whom it was long retained; but even in those countries where it lingered longest, in France and Scotland for instance, it is falling rapidly into desuetude.

Newell. In Architecture, the space, either solid or open, round which the steps of a staircase are turned.

Newspaper Reporting. The system of reporting, by which the parliamentary debates and speeches delivered at public meetings, &c. are given to the public. As it is contrary to the rules of both Houses that any stranger should be present, the publication of the debates is held to be a breach of privilege; but this regulation has always been defeated, either, as in former times, by the means adopted by Dr. Johnson and others of publishing the speeches of the different members under fictitious names, or, as at present, by the Houses themselves tacitly giving their sanction to the practice. The foundation of the present system of parliamentary reporting may be fairly ascribed to the late Mr. William Woodfall, whose retentive memory enabled him, after having listened to the debates, daily to communicate to the public, in what he called *A hasty Sketch of the Proceedings in Parliament last Night*, a full and accurate account of the different speeches. Secret deliberations, however, have been so long renounced, that the right of the public to be present through their agents, the reporters, is as clearly established now as if no theoretical privacy had ever existed; but if any member were repeatedly to insist upon the exclusion of *strangers*, as all are called who neither are members nor officers of the house, there can be no doubt that this abuse of the privilege must lead to such a modification of the standing order as would deprive individual members of any control over a matter so interesting to the nation. The process of parliamentary reporting and the qualifications of those by whom the task is performed, cannot be adequately described within the narrow limits of this article; but it is hoped that the reader may be enabled to form some idea of both from the following brief outline. Every publication not copying from or abridging any other, but giving original reports, keeps one of a series of reporters constantly in the gallery of the Lords, and another in the Commons. These, like sentinels, are at intervals of three-quarters of an hour relieved by their colleagues, when they take advantage of the respite to transcribe their notes, in order to be ready again to resume the duty of note-taking, and afterwards that of transcription for the press. A succession of reporters for each establishment is thus maintained, and the process of writing from their notes is never interrupted till an account of the whole debates of the evening has been committed to the hands of the printer. The publications for which reporters are constantly in attendance, are the London morning newspapers, from which all others that give debates are under the necessity of copying or abridging them. The number of reporters maintained by each varies from ten or eleven to seventeen or eighteen. They are for the most part gentlemen of liberal education—many having graduated at the universities of Oxford, Cambridge, Edinburgh, Glasgow, or Dublin. The expedition and ability with which their duties are performed must be admitted by every one who attends a debate and afterwards reads a newspaper; while the correctness and rapidity with which their manuscript is put in type and printed has long been a subject of surprise and admiration.

Newspapers. Publications in numbers, consisting commonly of single sheets, and published at short and stated intervals, conveying intelligence of passing events. In Rome, under the government of the emperors, periodical notices of passing events [ACTA DIURNA] were compiled and published; but our accounts of these ancient newspapers are somewhat obscure and uncertain. In modern Europe, the earliest occasional sheets of daily intelligence seem to have appeared at Venice, during the war of 1563 against the Turks [GAZETTE]; and the earliest regular paper appears to have been a monthly one, published in the same city by the state: but these were distributed in manuscript, and, owing to the jealousy of the government, were circulated in this form down to very late times. Extraordinary gazettes are said to have been published in England by authority, during the time when the arrival of the Spanish Armada was apprehended; but the specimens preserved in the British Museum, and so long regarded as authentic, are now demonstrated to have been forgeries.

Genuine English newspapers date from the first year of the Long Parliament, the oldest that has been discovered being a quarto pamphlet of a few leaves, entitled *The Diurnal Occurrences or Daily Proceedings of both*

Houses, in the Great and Happy Parliament, from November 3, 1640, *to November* 3, 1641. More than one hundred papers with different titles appear to have been published from this time to the death of the king, and upwards of eighty from that date to the Restoration. These were at first published weekly, but as the interest increased, twice or thrice a week, and even, it would seem, daily, at least for a time. Such were the *French Intelligencer*, the *Dutch Spy*, the *Scots Dove*, &c., but *Mercuries* of all sorts were the favourite title. Thus they had the *Mercurius Acheronticus, Aulicus, Britannicus, Laughing Mercury*, and *Mercurius Mastix*, which last faithfully lashed all the rest. The great newspaper editors of the day were Marchmont Needham on the Presbyterian, and Sir John Birkenhead on the Royalist, side. These were followed by Sir Roger l'Estrange, who has been ranked amongst the patriarchs of the newspaper press. This journalist is admitted to have been by no means deficient in readiness and shrewdness; but the acrimony displayed in his Tory paper, *The Observator*, against his unfortunate political adversaries is frequently ungenerous and even cruel.

'In 1685 (says Lord Macaulay) nothing like the London daily paper of our time existed, or could exist. Neither the necessary capital nor the necessary skill was to be found. Freedom too was wanting, a want as fatal as that of either capital or skill. The press was not indeed at that moment under a general censorship. The licensing Act, which had been passed soon after the Restoration, had expired in 1679. Any person might therefore print, at his own risk, a history, a sermon, or a poem without the previous approbation of any officer; but the judges were unanimously of opinion that this liberty did not extend to gazettes, and that, by the common law of England, no man, not authorised by the crown, had a right to publish political news. While the Whig party was still formidable, the government thought it expedient occasionally to connive at the violation of this rule. During the great battle of the Exclusion Bill many newspapers were suffered to appear, the *Protestant Intelligence*, the *Current Intelligence*, the *Domestic Intelligence*, the *True News*, the *London Mercury*. None of these was published oftener than twice a week. None exceeded in size a single small leaf. The quantity of matter which one of them contained in a year was not more than is often found in two numbers of the *Times*. After the defeat of the Whigs, it was no longer necessary for the king to be sparing in the use of that which all his judges had pronounced to be his undoubted prerogative. At the close of his reign no newspaper was suffered to appear without his allowance: and his allowance was given exclusively to the *London Gazette*. The *London Gazette* came out only on Mondays and Thursdays. The contents generally were a royal proclamation, two or three Tory addresses, notices of two or three promotions, an account of a skirmish between the imperial troops and the Janissaries on the Danube, a description of a highwayman, an announcement of a grand cockfight between two persons of honour, and an advertisement offering a reward for a strayed dog. The whole made up two pages of moderate size. Whatever was communicated respecting matters of the highest moment was communicated in the most meagre and formal style. . . . But the people who lived at a distance from the great theatre of political contention could be kept regularly informed of what was passing there only by means of newsletters. To prepare such letters became a calling in London, as it now is among the natives of India. The newswriter rambled from coffee-room to coffee-room, collecting reports, squeezed himself into the Sessions House at the Old Bailey if there was an interesting trial, nay, perhaps obtained admission to the gallery of Whitehall, and noticed how the king and duke looked. In this way he gathered materials for weekly epistles destined to enlighten some county town or some bench of rustic magistrates. Such were the sources from which the inhabitants of the largest provincial cities, and the great body of the gentry and clergy, learned almost all that they knew of the history of their own time. . . . It is scarcely necessary to say, that there were then no provincial newspapers. Indeed, except in the capital and at the two universities, there was scarcely a printer in the kingdom. The only press in England north of Trent appears to have been at York.' For the history of the newspaper press from this period to the end of the seventeenth century, see Macaulay's *History*, vol. iv. pp. 604–606.

From their first imperfect beginning, newspapers have gradually increased in number, matter, and consequence, until they form, in many European countries, one of the most important features in the social economy of the people; exercising a marked influence on domestic manners, literature, and usages, but more especially powerful as a great political instrument. London newspapers, and indeed many of the principal provincial papers also, are remarkable for the great mass and variety of matter which they contain, the ability of their leading articles, the rapidity with which they are printed and circulated, and the accuracy and copiousness of their debates. The piracy existing in the newspaper press is a difficulty under which the leading newspapers are placed in consequence of the want of any available copyright in the news or articles which they supply.

In Great Britain newspapers are subjected to several statutory enactments. By 6 & 7 Wm. IV. c. 76 no person can print or publish any newspaper until a declaration has been delivered at the Stamp Office, stating the name and places of abode of the printer, publisher, and proprietor; specifying the amount of shares in the undertaking, the title of the paper, and de-

scription of the building in which it is intended that the paper shall be printed. A copy of every newspaper is to be delivered, upon the day of publication, to the commissioners of stamps, under a penalty of 20*l.* Persons publishing newspapers without the name and place of abode of the printer affixed, are made liable to a penalty of 20*l.* for each offence, and peace officers, by virtue of a warrant from a justice of the peace, may enter any place to make search, &c. By 60 Geo. III. c. 9 every periodical, pamphlet, or paper, published at intervals not exceeding twenty-six days, containing public news or intelligence, or any remarks thereon, or on any matter in church or state, not containing more than two sheets, or published at a less price than sixpence, shall be deemed newspapers. By 1 Wm. IV. c. 73 securities may be demanded, to the amount of 400*l.* or 300*l.*, from both principal and sureties, when it is intended to publish a newspaper or pamphlet of the description mentioned in 60 Geo. III. c. 9. These securities are intended to secure payment of damages or costs which may be incurred in an action for libel against the conductor of the paper. The stamp duties on newspapers were repealed in 1859. By 18 & 19 Vict. c. 27 it is not compulsory to print newspapers on paper stamped with the duty imposed by 13 & 14 Vict. c. 97, except for the purpose of their transmission by post free of charge.

In France newspapers are generally undertaken in shares. The editors and principal writers are more responsible and more generally known than in England: this is either a cause or an effect of the general prejudice in that country against anonymous writing, which is by no means so common as among ourselves, but perhaps one of its consequences is, that newspapers are more notoriously under the control of particular sections of the political world, or of powerful individuals. Political newspapers have their subsidiary articles on subjects of theatrical or literary criticism added in the shape technically termed *feuilleton*, a subdivision of the page. This custom was introduced about 1800 in the most influential paper of that period, and has since been generally followed. The periodical press of France was under strict control during the Empire; the censorship was continued until 1819, and re-established in 1820, but again abolished in 1821. At that period a law was passed compelling the proprietors to give security for the good conduct of their journals, under a penalty of 10,000 francs in Paris, and various lesser sums in the departments. The censorship was, however, again instituted, and again abolished in 1827. By the famous ordinances of 1830 the liberty of the periodical press was suspended. In 1835, laws of a very severe character were passed, to subject the proprietors of journals to easier conviction and heavier punishment, in case of transgressing the existing laws of libel against government or individuals, and extending and multiplying the provisions of that law. In December 1851, the revolutionary government of Louis Napoleon Bonaparte commenced its career with a sweeping suppression of the press unparalleled in modern times. The *Gazette de France* appeared regularly from 1631 to 1792, forming a collection of 163 volumes; it was continued, also, but with some interruptions, through the period of the Revolution.

According to Mitchell's *Newspaper Press Directory* for 1865, the present position of journalism may be thus stated:—

There are 1,271 journals published in the United Kingdom, distributed as follow:—

England	944
Wales	41
Scotland	140
Ireland	132
Channel Islands . . .	14

The daily papers published in the United Kingdom may be distributed as follow:—

England	48
Wales	1
Scotland	11
Ireland	12
Channel Islands . . .	1

And these may be particularised thus:—

In England: Birmingham, 2; Bristol, 3; Hull, 2; Leeds, 1; Liverpool, 5; London, 20; Manchester, 3; Newcastle, 3; Nottingham, 3; Plymouth, 2; Sheffield, 2; Shields, 1; Sunderland, 1.

In Wales: Cardiff, 1.

In Scotland: Dundee, 2; Edinburgh, 4; Glasgow, 4; Greenock, 1.

In Ireland: Belfast, 2; Cork, 4; Dublin, 6.

In the Channel Islands: Jersey, 1.

In the United States, newspapers have made rapid strides, if we regard only the quantity of matter; between two and three thousand separate newspapers being published, with a circulation which may be counted by millions.

Newton's Rule. In Algebra, a rule given by Sir I. Newton, in his *Arithmetica Universalis*, part ii. chap. ii., for finding limits to the number of positive and to the number of negative roots of an equation. Prof. Sylvester, who was the first to demonstrate this rule, describes it thus, in a paper first published in the *Proceedings of the London Mathematical Society* (1865):

$$f(x) = a_0 x^n + n a_1 x^{n-1} + \frac{n(n-1)}{1.2} a_2 x^{n-2} + \dots$$

$$+ n a_{n-1} x + a_n = 0,$$

being an equation of the n^{th} degree, $a_0 a_1, \dots a_n$, are termed its *simple* elements, and

$$A_0 = a_0^2,\ A_1 = a_1^2 - a_0 a_2,\ \dots$$

$$A_{n-1} = a^2_{n-1} - a_{n-2} a_n,\ A_n = a^2_n$$

its *quadratic* elements. Further, a_r, a_{r+1} is termed a *succession* of simple, and A_r, A_{r+1} a succession of quadratic elements: $\left.\begin{matrix} a_r & a_{r+1} \\ A_r & A_{r+1} \end{matrix}\right\}$ being an associated couple of successions.

Now each succession in an associated couple may contain a *permanence* or a *variation* of signs. Thus an associated couple may consist of two permanences (*double permanence*), of a superior variation and inferior permanence (*variation-permanence*), and so on. These denominations being accepted, Newton's rule, in its complete form, may be stated thus :—

'On writing the complete series of quadratic under the complete series of simple elements of $f(x)$, in their natural order, the number of double permanences in the associated series so formed is a superior limit to the number of negative roots, and the number of variation-permanences in the same is a superior limit to the number of positive roots in $f(x)$.' As a corollary it follows that the number of imaginary roots cannot be less than the number of variations in the series of quadratic elements.

Prof. Sylvester has also greatly generalised the rule of Newton; for instance, he gives a theorem having the same relation to Newton's rule that Fourier's theorem bears to Descartes' rule.

Newtonian Philosophy. This term is used in various senses. Sometimes it is used to denote the doctrine of the universe as delivered by Sir Isaac Newton in the *Principia*; sometimes the corpuscular, or modern, or experimental philosophy, as opposed to the theories of Descartes and others; but most frequently, perhaps, the mathematical theory of universal gravitation. [GRAVITATION; PHYSICS.]

Nexi (Lat. part. of necto, *I bind*). In Roman Antiquities, persons freeborn, who, for debt, were delivered bound to a creditor, and obliged to serve him until they could discharge it. On the abolition of the law of Nexum, see Sir G. C. Lewis *On the Credibility of Early Roman History* ii. 479.

Next Friend of an Infant or Married Woman. In Law, one who institutes and conducts suits in equity in the name and on behalf of the party. Any person sui juris may act in this capacity, provided his interest is not adverse to that of the party. In the case of a married woman, her consent must be obtained; but no consent is necessary in the case of an infant. In either case the next friend is responsible for the costs of the proceedings.

Nibelungen, Lay of the. The name given to the most ancient existing monument of German epic poetry. It is supposed to have existed, in substance at least, two centuries before the reign of Charlemagne, and, like the early compositions of poets in all ages, to have consisted originally of detached ballads and poems, which were afterwards gradually collected, and at length moulded into the complete form in which they at present exist. [EPIC.] The last of the modifications which it underwent took place towards the end of the twelfth century, and is attributed to the Minnesinger Heinrich von Ofterdingen. The story turns upon the adventures of Kriemhilt, who is localised in Burgundy, and is first won by the valiant Siegfried, and after he is treacherously murdered gives her hand to Atli (identified with Attila, king of the Huns), chiefly in the hope that through his power and influence she may be revenged on the murderers of her former lord. The assassins, accordingly, and all their kin, are induced to visit Atli, when, by the instigation of the queen, a deadly feud arises, in the course of which almost the whole army on both sides is cruelly slaughtered. By the powerful but reluctant aid of Dietrich of Bern (Theodoric, who conquered Odoacer at Ravenna, in the famous Rabenschlacht, and lived at Verona, Bern), the murderer of Siegfried is at last vanquished, and brought bound to the feet of the queen, who relentlessly raises the sword of the departed hero, and with her own hand strikes off the head of his enemy. The famous Hildebrand, whose exploits are depicted in the *Heldenbuch*, instantly avenged the act by stabbing the queen, who falls exulting on the body of her hated victim. The work is divided into thirty-eight books. The *Nibelungen Lied* formed for many centuries the chief traditionary record of the romantic deeds and sentiments of the German nation, but at the era of the Reformation it sank wholly into oblivion; from which, however, it has within the last thirty years been rescued, and permanently placed, by the labours and commentaries of Hagen, Zeune, Simrock, and Schlegel, among the most conspicuous monuments of human genius.

Among the heroic poems of those nations which, in contradistinction to those of the Greeks, whose skilful unfolding of incidents and dramatic vividness of representation were unrivalled, have remained satisfied with a more simple mode of poetry, the *Nibelungen Lied* claims a very high place—perhaps among all the heroic chivalrous poems of Northern Europe it is entitled to the first. It is a series of pictures, each naturally following the other, and all delineated with great boldness and simplicity, and a total disregard of all superfluities. The German language appears in this work in a state of perfection to which in the subsequent periods of its early history it had no pretensions. In the *Nibelungen Lied*, in the same manner as in the legends of Troy and of Iceland, the interest turns on the fate of a youthful hero, invested with all the attributes of beauty, magnanimity, and triumph, but dearly purchasing all these glories by the certainty of an early and predicted death. [MYTHOLOGY, COMPARATIVE.] If the last catastrophe of the German poem be more tragical than anything in the *Iliad*, the death of the German hero, on the other hand, has in it more solemnity, stillness, and tenderness. The groundwork of the lay is the same as that of the older VOLSUNGA SAGA. (Dasent's *Popular Tales of the Norse*, Introduction; Max Müller's *Comparative Mythology*, p. 68 &c.; Schlegel's *History of Literature*, Edin. 1818, vol. i. pp. 270, 272.)

Nicaragua Wood. The wood of the *Cæsalpinia echinata*, a tree growing in Nica-

ragua; it is a species of Brazil wood, and is used, with solution of tin as a mordant, to dye a bright but fugitive red.

Nice, Council of. The first œcumenical council held in the Christian church. It was convened, A.D. 325, at Nicæa in Asia Minor by the emperor Constantine, in order to settle differences that had arisen in respect to the doctrines of Arius. This council was attended by upwards of 250 bishops, of whom a great majority came from the East, besides presbyters, deacons, and others from all parts of the Christian world. The chief question was the Arian heresy; and the council issued in the excommunication of Arius. [ARIANS.]

Nicene Creed. The confession of faith in which the consubstantiality of the Father and Son is asserted against the Arians. [ARIANS.] This creed was commenced by the council of Nice, A.D. 325, and completed by the second general council of Constantinople, A.D. 381. But the words 'and the Son,' after those 'Who proceedeth from the Father,' were added by the Latin church (certainly before A.D. 411), expressing a point of doctrine in which it differs from the Greek. The Nicene Creed was generally used by the Eastern churches in the administration of baptism; but was not inserted in their daily service till the fifth century. In the service of the church of Rome it was inscribed A.D. 1014.

Niche (Fr.; Ital. nicchia). In Architecture, a square or a cylindrical recess, formed in a wall, to receive a vase, statue, or other erect ornament.

Nickel. A white metal discovered by Cronsted in 1751; it is ductile, malleable, attracted by the magnet, and, like iron, may be rendered magnetic. Its specific gravity when hammered is about 9. It is rather more fusible than pure iron; is not altered by exposure to air and moisture at common temperatures, but is slowly oxidised at a red heat. It is found in meteoric iron. Its principal ore is a copper-coloured mineral found in Westphalia, and called *kupfernickel*, nickel being a term of detraction used by the German miners, who expected from the colour of the ore to find that it contained copper. It is also obtained from an impure arsenide, known under the name of Speiss. The salifiable oxide of nickel, NiO, consists of 30 nickel + 8 oxygen. Its salts are mostly of a grass-green colour, and the ammoniacal solution of its oxide is deep blue, like that of copper. Ferrocyanide of potassium precipitates it of a white or very pale green colour.

An alloy of nickel and *iron* forms an ingredient in most *aërolites* and in the masses of native iron found in various parts of the world, in which the proportion of nickel varies from 1·5 to 8·5 per cent. With *copper*, nickel forms a hard white alloy. The *white copper* of the Chinese, or *Pakfong*, consists of 40·4 parts of copper, 31·6 of nickel, 25·4 of zinc, and 2·6 of iron. A similar alloy is often used as a substitute for silver, or for plated articles, under the name of *German silver* or *Argentane*. These white alloys, when plated with silver, have over plated copper the advantage of not showing a red metal upon worn edges.

Nickel Bloom. Native arsenate of nickel. [NICKEL OCHRE.]

Nickel Glance. Native sulphide of nickel, sometimes containing arsenic and antimony.

Nickel Ochre. Native arsenate of nickel. It occurs in short capillary crystals of an apple-green colour; and also in earthy friable masses.

Nickel Pyrites. Native sulphide of nickel or Capillary Pyrites. [MILLERITE.]

Nickel Vitriol. A hydrated sulphate of nickel, occurring generally as a greenish-white efflorescence upon a sulphide of nickel and iron at Wallace Mine, Lake Huron.

Nickeline. [NICKEL OCHRE.]

Nicolaitans. One of the earliest Christian sects, mentioned in the Apocalypse, where the angel of God reproaches the church of Pergamos with harbouring persons of this denomination. They are there characterised as inclining to the licentious and pagan practices of the Gentiles; but the fathers have also accused them of partaking in a great measure of the Gnostic opinions. It is doubtful, however, whether on this point there be not some confusion between the Nicolaitans of the first and the followers of Nicolaus of the second century.

Nicolo. [ONICOLO.]

Nicotiana (so named after Jean Nicot, a Frenchman, who in the year 1560 first sent the seeds of tobacco into France). The genus of *Solanaceæ* to which the Tobacco plant belongs. The Tobacco of commerce is furnished by two or three species, but chiefly by *N. Tabacum*, a tall-growing annual plant, with large oblong lance-shaped leaves, and pink funnel-shaped flowers. This sort is largely cultivated in the southern states of America, in China, in Holland, Germany, France, &c. *N. rustica*, a smaller plant with ovate leaves and green flowers, is cultivated in many parts of the world: and *N. persica, repanda, quadrivalvis, multivalvis*, and *latissima* are also grown for their produce.

Tobacco forms an important article of commerce. In 1864 the total imports into the United Kingdom amounted to 66,615,176lbs., the value of which was computed at 3,448,294*l*., of which 37,951,928lbs. were retained for home consumption, and yielded in duty a revenue of 6,080,184*l*. Snuff is manufactured by grinding the dried and prepared tobacco leaves.

Nicotianin. The essential oil of tobacco, obtained on distilling the leaves with water. It has the appearance of a camphor, and by distillation with caustic potash is said to give nicotine.

Nicotine. A volatile poisonous alkaline base, extracted from the leaves and seeds of the *Nicotiana Tabacum*, or common Tobacco, the physiological effects of which are due to this base.

Nictitation (Lat. nicto, *I wink*). Winking of the eyes. This is generally a nervous affec-

tion, and very frequently it becomes a trick or habit. Where it arises from any local irritating cause, bathing the eyes with warm water affords relief.

Niddui. A sort of minor excommunication among the Hebrews, which continued usually about a month. If not removed within that period, it was prolonged for sixty or even ninety days. If during this term satisfaction was not made, the excommunicated person fell into the *cherem*, which was the second species of excommunication; and afterwards into the *scammatha*, which was the most dreadful of all.

Niello (Ital.). A method of engraving on plate. [ENGRAVING.]

Nigella (Lat. dim. of niger, *black*). A small genus of *Ranunculaceæ*, containing a few rather pretty border flowers, *N. damascena*, *romana*, and *hispanica*, familiarly known by the name of Devil-in-a-bush; and comprising also the *N. sativa*, a black-seeded aromatic species, used in Eastern countries as a substitute for pepper.

Nigged Ashlar. A mode of dressing the surface of stone, in which the face is left rough, or dressed only with a pointed hammer, instead of a chisel; this kind of work is also known by the name of *hammer dressed*, and it is generally employed in basements, or rough masonry where the appearance of strength is desired.

Night Blindness. An affection of the eyes, supposed to be caused by a partial paralysis of the retina. (Walker *On Nyctalopia*.) The disease prevails chiefly among the lumberers in the remote backwoods of Canada. (Hind's *Labrador* i. 153.) [HEMERALOPIA.]

Night Heron. [ARDEA.]

Night Watch. A period of the night as distinguished by a change of the watch. Among the Romans the night was divided into four watches, and styled first, second, third, and fourth watches, according to the military usage, by which the guard was relieved four times during the night. The first watch began at six in the evening and lasted till nine, according to our mode of computing time; the second lasted from nine till twelve or midnight; the third from midnight till three in the morning (called *cock-crowing*); and the fourth commenced at three and ended at six, thus completing the twelve hours. The Jews originally divided the night into three watches; but at a later period they adopted the Roman division of the night, which is frequently referred to in the New Testament.

Night-jar. The name of a remarkable British bird, the type of the genus *Caprimulgus*, distinguished by the wide gape of its beak, whence perhaps has arisen the popular idea of its sucking the teats of cattle, and its other common name *goat-sucker*, the equivalent of which it has received in most European languages, and which Linnæus has continued in its generic designation. It is scarcely necessary to remark that the structure of the bill renders the act of sucking impracticable in the night-jar or in any other bird. The genus *Caprimulgus* is characterised by a wide and deeply-cleft beak, armed with strong bristles, and capable of engulfing the larger insects; the nostrils placed at its base are like small tubes; the wings are lengthened; the feet short, feathered to the toes, which are connected together by a membrane at their base; the claw of the middle toe is commonly pectinated at the base. The night-jars are most active, and hunt their prey in the dusk; they have the same light and soft plumage as other nocturnal birds. Our common species (*Capr. europæus*) is remarkable for the loud sound it emits, like the burr or jarring of a spinning-wheel.

Nightingale (A.-Sax. nihtegale; Mr. Wedgwood connects the last syllable with the Lat. gallus). A migratory species of Passerines, and the sweetest of song-birds; the type of the subgenus *Luscinia*, which is more closely allied, according to Mr. Blythe, to the thrush family, than to the fauvettes (*Currucidæ*), among which it is placed by Cuvier. The males of the nightingale reach the southern counties of England sometimes in April, but more commonly not till the beginning of May; the females do not arrive till a week or ten days after the males. Migrating from the south, they visit this country for the purpose of breeding, and the famed song of the male is his *love chant*, and ceases when his mate has hatched her brood. 'Vigilance, anxiety, and caution now succeed to harmony; and his croak is the hush, the warning of danger and suspicion, to the infant charge and the mother bird.' If by accident his mate be killed, the male resumes his song; and will continue to chant very late in summer unless he can attract, as he commonly soon does, another female. The nightingale feeds chiefly on the larvæ of insects, which abound at the season of its arrival in this country. The nest is built near the ground; the eggs are four or five in number, of a uniform dark brown colour: the young are excluded in the month of June, and are ready to accompany the parents in their southward migration in the month of August.

Nightmare. [EPHIALTES; INCUBUS.]

Nightshade. [DULCAMARA; BELLADONNA.]

Nigrine (Lat. niger, *black*). The reddish-brown or black varieties of titaniferous iron, from Transylvania. It occurs in pebbles and in square translucent prisms which exhibit a blood-red colour at the edges.

Nilometer. An instrument, similar to our tide gauges, for measuring the rise of the Nile during the periodical floods. It is erected on the island of Er-Ródah, and consists of a graduated pillar upon which the height of the water is read off. The pillar stands in a kind of well which communicates with the river.

Nimbus (Lat.). In Painting and Sculpture, a circular disc round the heads of divinities, sovereigns, and saints. [AUREOLA; GLORY.]

Nimbus Cloud. In Meteorology. [CLOUD.]

Nine-points Circle. [CIRCLE, SIX POINTS.]

Ninth (Ger. neunte, Lat. nonus). In Music, one of the dissonant intervals, being the ninth from the fundamental or an octave above the second, with which, however, it is not to be confounded, as its harmonial and contrapuntal treatment is different.

Ninsin. The French name of the Ginseng, *Panax quinquefolium*, the root of which is sometimes called Ninsin Root.

Niobe (Gr. Νιόβη). In Mythology, a daughter of Tantalus, married to Amphion, king of Thebes. Proud of her children, she provoked the anger of Apollo and Artemis, who slew them all: her grief turned her into stone. (Soph. *Electr.* 151.) This fable is the subject of the beautiful group in the tribune at Florence, known by the name of *Niobe and her Children*. Some antiquaries attribute it to Scopas: Winkelman inclines to believe it the workmanship of Praxiteles.

Niobium. A metallic element, discovered in Bavarian Tantalite by Rose. It is probably identical with Columbium discovered in 1801 by Hatchett in a mineral called Columbite, found in North America.

Nippers. In Sea language, small ropes for attaching the messenger to the cable.

Nisi Prius (Lat.). In Law, a term originating in a legal fiction. When the pleadings in a cause in one of the superior courts of common law [PLEADING] were concluded, and an issue of fact was raised between the parties, the issue was appointed, by the entry on the record or written proceedings, to be tried, by a jury from the county wherein the cause of action arose, at Westminster, *unless before* (nisi prius) the day appointed the judges of assize should have come to the county in question, which in practice they always did, in the ordinary course of their circuits; and the causes were tried before them accordingly by virtue of their commission of nisi prius, which empowers them to try all questions of fact issuing out of the courts of Westminster that are then ripe for trial by jury. Since the Common Law Procedure Act 1852, the *nisi prius proviso*, as it was called, has been disused, and the trial now takes place on circuit as a matter of course. Causes triable at nisi prius in London or Middlesex are tried at the London or Westminster sittings, held in and after every term. [COURTS, SUPERIOR.]

Nitraria (Lat. nitrum, *nitre*). This genus of *Malpighiaceæ* from Central Asia and Northern Africa, consisting of thorny shrubs with fleshy leaves, is said to yield, in the species called *N. tridentata*, the lotus-tree of the ancients. [LOTE-TREE.]

Nitrates. Salts of the nitric acid. [NITRE.]

Nitratine or Chili Saltpetre. A native nitrate of soda covering large areas on the borders of Chili and Peru, and also in Bolivia; sometimes to a depth of several feet.

Nitre (Lat. nitrum, Gr. νίτρον). *Nitrate of potassa; saltpetre.* This salt (KO, NO_5) consists of 54 nitric acid + 47 potassa; its equivalent, therefore, is 101. It is spontaneously generated in the soil, and crystallises upon its surface in several parts of the world, especially in India, whence nearly the whole of the nitre used in Britain is derived. The cause of its formation is not well understood; it is probably connected with the oxidation of ammonia. The greater part of the rough nitre imported from the East Indies is in broken brown crystals, which are more or less deliquescent. Exclusive of other impurities, it often contains a considerable portion of common salt, which, reacting upon the nitre, sometimes induces the production of nitrate of soda and chloride of potassium; it also usually contains sulphate of lime and traces of organic matter. In Germany and France, it is artificially produced in what are termed nitre-beds. The process consists in lixiviating old plaster rubbish, which, when rich in nitre, affords about five per cent. Refuse animal and vegetable matter, which has putrefied in contact with calcareous soils, produces nitrate of lime, which affords nitre by mixture with carbonate of potash.

The loss which rough nitre sustains in refining is technically termed the *refraction*, and can only be ascertained by analysis, which frequently is somewhat intricate.

Nitre crystallises in anhydrous, six-sided prisms, usually terminated by dihedral summits. Its sp. gr. is about 2. The solubility of nitre varies extremely with temperature: at 32°, 100 parts of water dissolve 13·2 of salt; at 77°, 38 parts; at 132°, 97 parts; at 176°, 169 parts; and at 212°, 246 parts. During the solution of 1 part of powdered nitre in 5 of water, the temperature sinks from 50° to 35°. It is insoluble in pure alcohol. The crystals of nitre, though the salt is anhydrous, generally contain interstitial water; so that they appear moist when powdered, and lose weight on drying. The taste of nitre is cooling and peculiar.

At a temperature of about 600°, nitre fuses without undergoing change of composition, and congeals on cooling. Sometimes it is cast into small balls or cakes, called *sal prunella*. At a red heat, nitre is slowly decomposed; and highly heated in an earthen retort, or gun-barrel, it affords oxygen gas, mixed with a portion of nitrogen. In this decomposition, the nitre is first converted into *hyponitrite of potash*, which is somewhat deliquescent; potash is the final result.

Nitre is rapidly decomposed by charcoal at a red heat, and the results are carbonic oxide and acid, nitrogen, and carbonate of potash, formerly called *nitrum fixum* and *white flux*. These mixtures of nitre and charcoal form the basis of a variety of compositions used for fireworks, the rapidity of the combustion being modified by the relative proportion of the charcoal. When phosphorus is inflamed upon nitre, a vivid combustion ensues, and a phosphate of potash is formed. Sulphur sprinkled upon hot nitre burns, and produces a mixture of sulphate and sulphite of potash, formerly employed in medicine under the name of *polychrest salt*. Many of the metals, when

in filings or powder, deflagrate and burn when thrown on red-hot nitre.

For the use of nitre in GUNPOWDER, see that article.

Nitre has sometimes been mistaken for Glauber's salt, and, when taken in the quantity of half an ounce or an ounce, it acts as a powerful poison. In such cases the stomach should be evacuated as rapidly as possible, and the symptoms of spasm relieved by opiates. In doses of 5 to 15 grains it is diuretic and diaphoretic.

Nitrate of soda crystallises in rhombic crystals; hence termed *cubic nitre.* It is found plentifully in Chili and Peru, and is imported from America. It is used as a manure and as a source of nitric acid, but, being slightly deliquescent, it cannot be employed in the manufacture of gunpowder.

Nitric Acid. (NO_5.) This acid is a compound of 1 atom or equivalent of nitrogen $=14$, and 5 of oxygen $(8 \times 5)=40$; hence its equivalent in the dry or anhydrous state is $14+40=54$. As it usually occurs in the liquid state, it is a compound of 1 equivalent of dry acid, 54, and 2 of water (9×2), 18; hence the equivalent of the liquid acid is 72. It is commonly known in commerce under the name of *aqua fortis,* and is prepared by distilling a mixture of sulphuric acid and nitrate of potash, or of soda. It is commonly yellow, or orange coloured; but it may be deprived of nitrous acid, which occasions this colour, by heat, and it then becomes colourless. It is intensely corrosive and sour, fumes when exposed to air, and has a specific gravity of 1·50 when in its utmost state of concentration. It boils at 248°, and freezes at $-50°$. It is a powerful oxidising agent, and is decomposed with more or less rapidity by almost all the metals, and acts intensely upon most organic bodies, imparting to them a yellow tinge.

The salts which it forms are called *nitrates*; they are all soluble in water; they are decomposed by heat, and, when mixed and gently heated with sulphuric acid, they evolve nitric or nitrous acid.

The composition of nitric acid was first synthetically demonstrated by Cavendish in 1785. He produced it by passing electric sparks through a mixture of 7 volumes of oxygen and 3 of nitrogen, a result verified by Faraday, in reference to the presence of traces of nitric acid in the rain of thunder-storms.

Anhydrous nitric acid was discovered by Deville in 1849, who obtained it by passing dry chlorine over dry nitrate of silver: it is a colourless crystalline solid, very unstable, and having a strong affinity for water.

Commercial nitric acid is generally contaminated by sulphuric and hydrochloric acids. When pure, no white cloud is produced in the diluted acid by a solution of nitrate of baryta, or nitrate of silver.

Nitric Oxide. (NO_2.) This gas was first discovered by Hales, and more accurately studied by Priestley. It is obtained during the action of nitric acid diluted with about two parts of water upon metallic copper; it is copiously evolved, and may be collected over water. 100 cubical inches weigh between 32 and 33 grains; its density, therefore, compared with air, is 1037. It is easily recognised, as it forms orange-coloured fumes whenever it escapes into the air or comes into contact with oxygen, so that this gas and oxygen are excellent tests of each other's presence. It consists of equal volumes of nitrogen and oxygen, or of 1 equivalent of nitrogen and 2 of oxygen; hence it is termed a binoxide or deutoxide of nitrogen. The respective weights of its components, therefore, are 14 nitrogen + 16 oxygen, and the equivalent of the gas is 30.

Nitrites. Salts of the *nitrous acid.*

Nitro-calcite. Native nitrate of lime. It occurs as an efflorescence upon old walls and on calcareous rocks in the form of silky tufts, with a sharp and bitter taste.

Nitro-magnesite. A native hydrated nitrate of magnesia, found with Nitrocalcite, which it resembles in colour and other characters.

Nitrogen (Gr. νίτρον; γεννάω, *I produce*). A simple gaseous body (represented by the symbol N), which forms a constituent of the atmosphere and of nitric acid, and which, being unrespirable, has also been termed *azote*: from ἀ, privative, and ζωή, life. It was identified as a peculiar gas by Dr. Rutherford in 1774, in which year it was also shown by Lavoisier to be one of the components of atmospheric air. It may be obtained, when not required absolutely pure, by burning a piece of phosphorus in a jar full of air inverted over water. The phosphorus during its combustion combines with the oxygen of the air to form phosphoric acid, which is dissolved by the water, and the remaining element of the air, namely the nitrogen, remains. Pure nitrogen may be obtained as follows: Place some *pyrogallic acid,* moistened with a strong solution of caustic potash, in a porcelain capsule floating on a water-bath, and invert a jar of air over it; the oxygen of the air will be more or less rapidly absorbed according to the quantity of the pyrogallic acid and the strength of the potash solution. In this case the carbonic acid, as well as the oxygen of the atmospheric air, is absorbed, so that the residuary nitrogen retains only aqueous vapour, which may be abstracted by any of the usual processes. Nitrogen is also obtained by passing air over shavings of metallic copper, heated to redness in a porcelain tube; the oxygen is retained by the copper, and the resulting nitrogen may be deprived of traces of carbonic acid by passing it through caustic potash, and of moisture by finally transmitting it over fused chloride of calcium. The decomposition of a solution of ammonia by the action of chlorine, has also been resorted to as a means of procuring nitrogen; in this operation the hydrogen of the ammonia combines with the chlorine to form hydrochloric acid, and the nitrogen of the decomposed portion of the ammonia is set free. If the ammoniacal so-

lution be very concentrated, the bubbles of chlorine as they pass into it often produce flashes of light and slight explosions, and care should be taken to avoid excess of chlorine, which might tend to the formation of the dangerously explosive compound known as *chloride of nitrogen*. Nitrogen is a colourless, inodorous, and tasteless gas, not absorbed by water, and having no action on vegetable colours. It extinguishes all burning bodies, and is itself uninflammable. It is a little lighter than atmospheric air, 100 cubic inches weighing 30·16 grains. Its equivalent is 14, and it combines with oxygen in 5 proportions, giving rise to the following compounds:—

	By volume N.	O.	By weight N.	O.	Equiv.	Symb.
1. Nitrous oxide	100+	50=	14+	8=	22=	NO.
2. Nitric oxide	100+	100=	14+	16=	30=	NO_2.
3. Hyponitrous acid	100+	150=	14+	24=	38=	NO_3.
4. Nitrous acid	100+	200=	14+	32=	46=	NO_4.
5. Nitric acid	100+	250=	14+	40=	54=	NO_5.

Nitrogen is an important component of many organic substances, and is remarkable as one of the constituents of most of the fulminating compounds, such as fulminating gold, silver, and mercury, and the chloride and iodide of nitrogen. Ammonia contains 82 per cent. of nitrogen. It forms *nitrides* with a few of the metals.

Nitrohydrochloric Acid. *Nitromuriatic acid.* The mixture of nitric and of hydrochloric acid; formerly called *aqua regia*, from its solvent power over gold, the *king* of the metals. When these acids are mixed, chlorine and nitric oxide are evolved, and a chloride of gold is formed.

Nitropicric Acid. A synonym of CARBAZOTIC ACID.

Nitroprussides. When nitric oxide is passed through an aqueous solution of hydroferricyanic acid, one of the products is *hydronitroprussic acid*, the formula of which is H_2, Fe_2Cy_5, NO_2: it forms a series of salts, discovered by Dr. Playfair (*Philosophical Transactions* 1848). One of the most characteristic of these is the *nitroprusside of sodium*: $Na_2, Fe_2Cy_5, NO_2 + 4Aq$. It forms red prismatic crystals, the solution of which, when exposed to light, deposits Prussian blue, and evolves nitric oxide; when an alkaline sulphide is added to it, even in a most diluted state, it assumes a deep and characteristic purple colour, which, however, soon disappears.

Nitrosaccharic Acid. By the action of sulphuric acid on gelatine a peculiar saccharine matter is formed (*glycosine*), which combines with nitric acid, and forms a crystallised acid designated as above.

Nitrosulphuric Acid. A compound of nitric oxide and sulphurous acid; only formed in the presence of bases. Its salts are easily decomposed, and the acid itself cannot be obtained in a separate form. This term has also been applied to an acid resulting from the mixture of one part of nitre with eight or ten parts of sulphuric acid, and proposed by Mr. Keir as a useful agent for separating the silver from the copper of old plated goods. At a temperature of about 200° it dissolves silver, while it scarcely acts upon copper or lead, unless diluted, or at higher temperatures.

Nitrous Acid. (NO_4.) *Hyponitric acid. Peroxide of nitrogen.* When two volumes of nitric oxide and one of oxygen are mingled in an exhausted glass globe, they form a dense orange-coloured vapour, which may be liquefied at 20°, and crystallises at 15°. Its elements are so condensed that 1 volume of nitrogen and 2 of oxygen form one volume of nitrous acid vapour, the specific gravity of which is 3·17. The presence of this vapour renders nitric acid red and fuming, in which state it is commonly termed *nitrous acid.*

Nitrous Oxide. (NO.) *Protoxide of nitrogen.* This gas was discovered by Priestley in 1776, who called it *dephlogisticated* nitrous air, but its properties were first fully investigated by Davy in 1800. It may be obtained by carefully heating pure nitrate of ammonia, which salt is thus resolved into nitrous oxide and water. This gas is liquefied under a pressure of 50 atmospheres, and solidified at a temperature of 150° below 0°. The specific gravity of this gas is 1·5, and its equivalent 22 (14 + 8). An ignited taper burns brilliantly in it, the flame being surrounded by a purplish halo.

Nitrous oxide is a narcotic poison, and when breathed, destroys life. It may, however, as was first shown by Davy, be taken by a human being in a small quantity; and if the lungs be emptied before it is inhaled, it rapidly causes a peculiar species of intoxication, manifested at first by unsteadiness of gait, and subsequently by violent muscular exertion. There is a brilliant flow of ideas, with, generally speaking, a great disposition to pugnacity. From the pleasing kind of delirium which it produces, it has been called *laughing or paradise gas.* When breathed, it is rapidly absorbed into the blood, and produces a great change in that fluid—manifested by a dark-purple colour of the lips, and by a livid or pallid appearance of the face. Some have fallen down at once powerless, but the greater number are thrown into a state of violent excitement. In general the exhilarating effects pass off in from five to ten minutes, and, with the exception of some prostration of strength and slight headache, no injurious symptoms follow. But in certain cases, probably from idiosyncrasy, the respiration of the gas has been attended with severe headache, giddiness, double vision, and even some delirium, with a feeling of weakness from exhaustion, lasting for several days.

Nizam. The title of one of the native sovereigns of India. It is derived from Nizam-ul-Mulk, who in the beginning of last century obtained possession of the Mohammedan conquests in the Deccan; his successors in the sovereignty having assumed his name as their title of dignity, which they have retained to this day.

Nobility (Lat. nobilitas). A general name for the highest orders of society. [ARISTOCRACY.] In most countries the term has denoted primarily an hereditary aristocracy. At Rome as in Athens [EUPATRIDÆ] the nobles, or patricians, formed strictly a caste, as distinguished from the plebs, all curule offices being in the hands of the former, and no right of intermarriage (jus connubii) with the privileged class being allowed to the latter. On the privileges of this order, which extended to the exclusive right of suffrage (jus suffragii), the plebeians gradually encroached with success, and all plebeians who had filled a curule office came to be regarded as belonging to the class of nobles. These *novi homines*, or new men, imparted fresh life to an aristocracy which, if it had remained exclusive, must soon have become extinct. Thus an order of Nobiles was formed which stood out in contrast with the Ignobiles; but while they had no *legal* privileges, they combined with the old patrician families to keep all offices of state as much as possible within the circle of their own order. They had, however, the external distinction of the *jus imaginum*, or the right of setting up the images or busts of their ancestors. [NOVI HOMINES; PEERAGE.]

Noble. An English coin of the middle ages, value 6*s*. 8*d*., current in the reign of Edward III. According to Knighton, the *rose noble* was a gold coin in use about the year 1344.

Noctiluca (Lat. literally *shining by night*). A term applied by Boyle and some of the older chemical philosophers to phosphorus.

Nocturn (Lat. nocturnus, *nightly*). An office consisting of psalms and prayers, celebrated in the Roman Catholic church at midnight. It is said to have been introduced into the West by St. Ambrose. It now forms part of the service of matins.

Nocturnals. A tribe of Raptorial birds, including those which fly by night, and have the eyes directed forwards: also a family of Lepidopterous insects, which, in like manner, are active chiefly in the night season.

Nodal Points or **Nodal Lines.** A vibrating chord can spontaneously divide itself into any number of aliquot parts, each of which will vibrate separately as if it were fixed at its two extremities and formed a separate chord. The points of separation between two such contiguous parts, which do not participate in the vibration of either the one or the other, but remain at rest, are called *nodal points*. In like manner, when elastic plates are put into a state of vibration, the molecules separate themselves into parcels which vibrate independently of each other; and the lines of separation thus formed, or lines of repose in which no vibration takes place, are called *nodal lines*. [VIBRATION.]

Noddies or **Boobies.** A group of marine birds of indistinct specific identity, belonging to the genus *Sula*, comprising the Gannets. The term is sometimes restricted to the large brown bird (*Sula fusca*) which is found in warm or temperate climates throughout the globe. The disinclination of these birds to fly at the approach of man, and the ease with which they can be knocked down with sticks, has led to the singular name applied to them by Dampier, De Gennes, and subsequent travellers.

Node (Lat. nodus, *a knot*). In Botany, a point situated upon the axis of a plant, whence a leaf or leaf-bud originates.

NODE. In Geometry, this word is synonymous with *double point*. In the theory of curves, the term *node*, however, is usually applied only to a double point, at which the two tangents are real and distinct; when these tangents coincide, the node becomes a *cusp* or *stationary point*, and when both tangents are imaginary, it receives the name of *conjugate* or *isolated point*. In the theory of surfaces, nodes are also called *conical points*, since the surface is there cut in *three consecutive points* by the generators of a quadric cone. [CONICAL POINT.] When this cone breaks up into two planes, the node is termed a *biplanar node*, and when these planes coincide, a *uniplanar node*. A *proper node* is one at which the cone in question does not so break up. A *nodal line* on a surface is a curve every point of which is a node.

NODE. In Surgery, a hard tumour upon a bone, which creates considerable pain, and often is attended by caries or necrosis. They are most common upon the tibia and bones of the head and fore-arm, where they are thinly covered by flesh.

Nodes. In Astronomy, the two points in which the orbit or the equator of a planet intersects the plane of the ecliptic. The point in which the centre of a planet passes from the south to the north side of the ecliptic is called the *ascending node*, and in astronomical computations is usually indicated by the symbol ☊; the opposite point, or that in which the planet passes to the south side of the ecliptic, is called the *descending node*, and is indicated by ☋. The straight line which joins these two points, formed by the intersection of the plane of the planet's orbit with the plane of the ecliptic, is called the *line of nodes*. The nodes of the lunar orbit were anciently called the head and tail of the dragon.

The position of the nodes on the ecliptic is one of the elements by which the situation of the plane of an orbit in space is defined; in fact, it is easy to see that, if the position of the line of the nodes, and also the inclination of the orbit to the ecliptic, be known, the position of the plane of the orbit is entirely determined. The two nodes being distant 180°, it is only necessary to indicate the position of one of them: the longitude of the ascending node, or its distance from the first point of Aries, is the element used by astronomers. In all the planetary orbits the line of the nodes is variable, having a retrograde motion from east to west in respect of the fixed stars, but so slow that it amounts only to a few seconds in a year. The regression of the moon's nodes is very considerable, as it completes a revolution in

about nineteen years. [MOON.] This retrograde motion of the nodes of all the planets is a necessary consequence of their mutual attractions. For the positions and variations of the nodes of the different planets, see PLANET. The nodes of a planet's equator are one of the elements of the planet's rotation, the inclination of the axis and time of rotation being the others.

Noël. The French name of Christmas-day, derived, it is said, from *dies natalis* (Lat. *birthday*).

Noetians. In Ecclesiastical History, a sect so called from Noetus, an Ephesian, the master of Sabellius. They acknowledged only one Person in the Divinity; and, consequently, were accused of maintaining that God the Father had suffered on the cross. [PATRIPASSIANS.]

Nog. The bolt or tree-nail which secures the heel of each shore employed in sustaining a ship in dock or on the slip.

Nogging. In Architecture, brickwork carried up between upright pieces or quarters, introduced in order to give the wall or partition greater lateral stiffness and strength.

Nogging Pieces. In Architecture, horizontal pieces of timber fitting in between the quarters, to which they are nailed in a brick nogged partition, which, by their resistance to lateral motion, they serve to steady and strengthen.

Nolanaceæ (Nolana, one of the genera). A natural order of perigynous Exogens of the Echial alliance, consisting of herbaceous or shrubby plants, natives of South America. They are distinguished by their straight inflorescence, regular flowers, free stamens, five nuts, and a naked stigma. None of them are of any known use, but the genus *Nolana* affords several ornamental annual flowers.

Noli Me Tangere (Lat. *touch me not*). In Surgery, a disease of the skin, commencing with small ulcerations which eat away the part. These ulcerations sometimes affect the cartilage of the nose, which is destroyed by their progress; almost all applications rather increase than stop the ravages of the disease, which has received the name of *lupus* (Lat. *wolf*) from its devouring qualities.

Noli-tangere. In Botany, the plant called Touch-me-not, the *Impatiens Noli-tàngere* of systematists.

Nolle Prosequi (Lat.). In Law, an acknowledgement or agreement by the plaintiff in a suit that he will not further prosecute it, either as to the whole or a part of the cause of action (for instance, on the defendant's demurring to one count in a declaration, the plaintiff may enter a nolle prosequi as to that count, and proceed to trial on the other counts), or as to one or more out of several defendants.

Nomades (Gr. νομάδες; from νομός, *pasture*). Tribes of men without fixed habitation. The nomades of ancient times were generally tribes devoted to pastoral pursuits; for the Greeks and Romans knew of no races subsisting wholly by the chase. The principal nomadic tribes of antiquity were those of Southern Russia and the interior of Asia, from whom sprang, in the decline of the Roman empire, many of the tribes which overran Western Europe; and, at a later era, those which conquered empires in Western and Southern Asia. The vast regions of Mongolia are inhabited by nations which still retain their wandering habits. [TURANIAN LANGUAGES.]

Nome (Gr. νόμος; from νέμω, *I divide*). The Greek name for the provinces into which Egypt was anciently divided. According to Diodorus Siculus, the division into nomes was made by Sesostris, whom some modern writers consider as identical with the Rameses II. of the monuments; but such statements refer to a time of which we have no historical knowledge. There were thirty-six nomes, which, in the time of Strabo, were thus divided—ten in the Thebaïd, sixteen in the Heptanomis, or intermediate district (which, according to its name, probably consisted in earlier times of seven only), ten in the Delta. This division was not materially altered until the latest age of the Roman government. (D'Anville, *Mémoires sur l'Égypte*; Wilkinson's *Manners and Customs of the Ancient Egyptians*, vol. ii.)

Nomenclator (Lat.). An officer employed by the candidates for the great state offices of Rome, to accompany them through the streets and whisper to them the names of such citizens as they might meet, in order that they might then address them by name, and canvass their votes. It is derived from Lat. nomen, and the old word calo, *I call*.

Nomenclature. A term originally applied to a catalogue of the most ordinary words in any language, with their significations, &c. But, in a more special sense, this term is employed to denote the language peculiar to any science or art: thus we speak of the nomenclature of chemistry, botany, &c.

Nominal Partner. In Law, one who allows his name to be used as having an interest in a partnership in which he has in fact no concern, and thereby subjects himself to the liabilities of the partnership, 'as against all the rest of the world.' [PARTNERSHIP.]

Nominalists. A term originally applied to a scholastic sect which arose in the eleventh century. Its founder was John Roscelin, a churchman of Compiègne, who asserted that general terms have no corresponding reality either in or out of our minds, being, in truth, words, and nothing more (*flatus vocis*). [LOGIC.] This doctrine naturally excited great consternation among the schoolmen, with whom, hitherto, all that was real in nature was conceived to depend on these general notions or *essences*. Its promulgator underwent much persecution for his opinions, and was ultimately compelled to retract them, as inconsistent with the doctrine of the Trinity, as it was then stated. He found, however, an able successor in the person of Peter Abelard, who attracted numerous disciples by his dialectical skill and

eloquence, and, with his followers, whom he led in a body to Paris, was the occasion of founding the celebrated university of that city. After his death the ancient realism was restored to its supremacy; nor do we meet with a nominalist until the thirteenth century, when William of Ockham revived his doctrines under some modifications. The last-mentioned philosopher may, in fact, with greater justice, be styled a conceptualist, as he distinctly stated the formation of general terms to depend on the conditions of thought, and hence to possess a species of subjective reality, as the sign or indication of an actual process of thought, though they were neither distinct objects of consciousness nor realities in nature. Those who hold either of the latter theories are realists. The controversy is one which has excited great attention among modern philosophers. Of these, Hobbes and Dugald Stewart may be considered strict nominalists, while Locke and Dr. Thomas Brown style themselves conceptualists. There are, however, expressions in Locke's writings which would rather stamp him as a realist, under the former of the two modifications which we have given above. [SCHOLASTIC PHILOSOPHY; THOMISTS; SCOTISTS.] (Hallam's *Literature of Europe in the Fifteenth, Sixteenth, and Seventeenth Centuries*, part i. ch. iii. § 67 &c.; Brucker's *Historia Critica Philosophiæ*.)

Nominative Case. In Grammar, that form of a noun which names or designates a substance *absolutely*, or without relation to any other substance.

Nomocanon (Gr. νόμος, *law*, and κανών, *canon* or *rule*). In Ecclesiastical Law, a work in which canons of the church, and imperial laws touching the same subjects, are collected and compared. The first was made by Joannes Scholasticus (A. D. 551). The most celebrated was that of Photius, patriarch of Constantinople.

Nomophylaces (Gr. νομοφύλακες, *guardians of the law*). At Sparta and elsewhere, magistrates whose duty it was to see that the laws were rightly administered and obeyed. At Athens, they were merely inferior police officers who had to keep order in the public assemblies; but some think that no officers so called existed there till the time of Demetrius Phalereus.

Nomothetæ (Gr. νομοθέται, *legislators*). An office instituted probably by Pericles. A certain number of citizens, chosen out of the 6,000 dicasts, were lotted off to sit together on special occasions, to decide on propositions for introducing new laws, &c. (Grote's *History of Greece*, part ii. ch. xlvi.)

Non Compos Mentis (Lat.). In Law, a person not legally responsible for his acts in consequence of mental deficiency. [LUNACY.]

Non est Inventus (*he is not found*). In Law, the formal Latin words anciently used in the sheriff's return to a writ of capias, that the defendant was not to be found within his bailiwick.

Non Prosequitur (Lat.) or **Non Pros., Judgment of.** This is a final judgment for costs, which may be signed by the defendant if the plaintiff in an action at law neglects to prosecute it. The corresponding course in a suit in equity is to move to dismiss the bill for want of prosecution.

Non-commissioned Officer. In the Army, one who, while he is not commissioned as an officer, holds an appointment by virtue of which he exercises authority over the private soldiers. Such are sergeant-majors, quartermaster sergeants, and sergeants. A non-commissioned officer can be reduced to the ranks by sentence of court martial or order of the colonel or other officer commissioned as *commandant* of his regiment; but so long as he holds his rank he can receive no minor punishment.

Non-feasance. In Law, the offence of omitting what ought to be done.

Non-naturals. A term applied by the old physicians to things which, although necessary to life, do not form a part of the living body; such as air, food, sleep, &c.

Non-obstante (Lat. *notwithstanding*). In old English Law, a license from the crown, usually conveyed by a clause in letters patent, &c., to do something which by common law might be done, but was restrained by Act of Parliament. Such license could of course only rest on high doctrines of prerogative, and were the means by which James II. endeavoured to carry into execution his celebrated *dispensation*, annulled by 2 Wm. & Mary c. 2.

Non-obstante Veredicto, Judgment. When the defence upon the record is not a legal defence to the cause of action, and the defendant obtains a verdict, the plaintiff may in some cases obtain leave to sign judgment notwithstanding the verdict. The defendant's course in a similar case is to move in arrest of judgment.

Non-resistance, The Doctrine of. In Politics, that doctrine which inculcates the unlawfulness, on religious grounds, of resistance by force to the commands of a prince or magistrate. This is strongly laid down in many books of the New Testament, and especially by St. Paul (Rom. xiii.). In its ordinary acceptation, the doctrine is understood to enforce the duty of obedience to the lawful commands of magistrates. But, in that peculiar sense which is attached to it in English constitutional history, it means unqualified obedience to every command, especially of the prince or supreme magistrate, whether lawful or not; and consequently it condemns all forcible opposition even to tyranny or usurpation. But the advocates of non-resistance, in this extended sense, do not appear to have ever contended that it applied to commands of inferior magistrates in the same sense and degree as to those of the highest: they therefore supposed a peculiar sanctity in the person and office of the sovereign which no other officer possessed; and thus combined the doctrine of

divine right with that of passive obedience or non-resistance. These doctrines are plainly laid down in the homilies of the church of England; in which, in the phrase of Bolingbroke (*State of Parties*), they *skulked* until the reign of James I. (See especially the Homily *On Wilful Disobedience and Rebellion.*) But in that reign they were more generally avowed by the learned and loyal; and in 1622 the university of Oxford sanctioned them by a solemn decree. The events which led to and followed the great rebellion naturally led men's minds to pay greater attention to the speculative part of politics; and, while Hobbes was framing a theory of absolute monarchy on the principle of the social contract, a different class of reasoners arrived at the same result through a peculiar interpretation of Scripture. Sir Robert Filmer (especially in his *Patriarcha*), Bishop Sanderson, and others, made the regal power originate in the patriarchal; and endeavoured to prove that all other forms of government, being unrecognised by Scripture, were usurpations. Dean Sherlock, the ablest writer of the school of divine right (*Case of Resistance to Supreme Powers*, 1684), endeavoured to prove the absurdity of the theory of the social contract, and to show from Scripture the unlawfulness of resisting any command, even of a usurping power. In answer to these reasoners Locke wrote his *Essay on Government*, in which he seeks to confute the arguments for unqualified non-resistance, by showing that Scripture and reason make no distinction between inferior and superior magistrates, and reducing his opponents to the absurdity of affirming that any command, however extravagant, of the lowest magistrate, must be obeyed. In 1683, the university of Oxford pronounced its second decree in favour of the tenets of divine right and non-resistance. But the current of court opinion changed at the Revolution. The doctrine of non-resistance was almost proscribed; but maintained by the non-jurors, who professed to *obey* the usurping government, while they refused to *recognise* it. In 1709 it was preached by Sacheverell, with the apparently inconsistent result of a riot. His sermon, together with the Oxford decree, was burnt by order of the House of Lords. But the doctrine has been within these few years asserted by the high church party. (Dr. Pusey's *Sermon on the 5th of November*, 1838.)

Nonæ et Decimæ (Lat.). In Ecclesiastical Law, the contributions of tenants of the church were anciently so called: the nonæ, or ninth part, standing for a species of rent, the decimæ for the tithe due to the church.

Nonage. In Law. [INFANT; MINORITY.]

Nonagesimal (Lat. nonagesimus, *the ninetieth*). In Astronomy, the *ninetieth* degree of the ecliptic, reckoned from either of the points in which it is intersected by the horizon. It is therefore the highest point of the ecliptic at any instant, and its altitude is equal to the distance of the pole of the ecliptic from the zenith. The nonagesimal is used in calculating the parallaxes of the moon.

Nonagon. A plane rectilineal figure having nine sides. [ENNEAGON.]

Nonconformists. A general term under which all the religious communities which do not conform to the liturgy of the established church of England may be comprehended, but usually confined to Protestant Dissenters. Historically, it belongs more properly to the large body of clergy who, at the Restoration, refused to subscribe to the Act of Uniformity, and were in consequence ejected from their benefices on St. Bartholomew's day, 1662. This Act was first promulgated by Elizabeth, and required all the clergy to use the Book of Common Prayer, and inflicted severe penalties upon any one who should be convicted of speaking or preaching against it. The Act of Charles II. contained provisions still more strict, enjoining every beneficed person not only to use the book, but to declare his assent and consent to every part of it: and enacting that unless this were done on a certain day he should be, ipso facto, ejected. Other declarations were also to be subscribed; as, 'That it is unlawful to take arms against the king on any pretence whatsoever;' 'That no obligation from the covenant lies upon himself or any other person.' It is said that two thousand persons resigned their preferments in consequence; and even after this their party was subjected to the further infliction of the Conventicle Acts, which forbade more than five persons besides the family to assemble together in any house for religious worship; and the Five Mile Act, which subjected to penalties and imprisonment any nonconformist clergyman who should take up his residence within five miles of any corporate town, or other place where he had been minister. [DISSENTERS.]

Nones (Lat. Nonæ). In the Calendar, one of the three divisions of the Roman month, and so called because they fell on the *ninth* day, reckoned inclusively, before the ides. In the months of March, May, July, and October, the ides fell on the 15th day of the month, and the nones, consequently, on the 7th. In the other months, the ides were on the 13th day, and the nones on the 5th. [CALENDAR; CALENDS; IDES.]

Nonius. A name frequently given to the vernier (a useful contrivance for subdividing the divisions of graduated arcs or scales into minute parts), from an erroneous idea that it was invented by Pedro Nunez, or Nonius, a Portuguese, who lived in the early part of the sixteenth century. The contrivance employed by Nonius was widely different from the vernier now universally used. It consisted in describing within the same quadrant 45 concentric arcs, dividing the outermost into 90 equal parts, the next into 89, the next into 88, and so on, the innermost being consequently divided into 46 only. With this instrument the observed altitude of an object could be read off on the outermost arc only to degrees, but the fractions were obtained in the following

manner: the plumb-line, or movable index, must intersect one of the concentric arcs at, or very near, a point of division. Now, it is evident that the number of parts read off at this point must be in the same proportion to the degrees and fractions of a degree intercepted on the outermost arc, as the number of parts into which the arc containing the point is divided, is to 90°. The division read off being therefore multiplied by 90, and divided by the number of parts in the arc, gives the observed altitude to fractions of a degree. Thus, if the plumb-line intercept 25 parts exactly on the arc in which the number of parts is 78, the angle measured will be 28·846°: the fraction is easily converted into minutes and seconds. Nonius supposed that this artifice was known to Ptolemy. It was adopted by Tycho Brahe; but soon abandoned by him for the method of diagonal divisions, in consequence of the difficulty of dividing accurately the different arcs. (Robins's *Mathematical Tracts*, vol. ii.) [VERNIER.]

Nonjurors. In English History, that party among the clergy of the national church who refused to take the oath of allegiance to the new government after the Revolution. Eight bishops, including the primate Sancroft, with about four hundred clergy, were in consequence ejected from their benefices. Of these the most learned was Hickes, bishop of Peterborough. The ecclesiastical history of Great Britain by Jeremy Collier is written on their principles. They maintained a strict and necessary connection between the national church of England and the catholic church throughout the world; and while they denounced the special errors of the Romish branch of the church, allowed it an indefeasible precedence and authority. In politics they held the doctrines of divine right and passive obedience. The nonjurors maintained their ecclesiastical position through the greater part of the last century, their bishops continuing to ordain and consecrate; but their numbers dwindled away, and Dr. Robert Gordon, who died in November 1779 at a very advanced age, was the last in their episcopal succession. [JACOBITES; PRETENDER.]

Nonpareil. In Printing, the name of a kind of type two sizes smaller than that used in this work. It was called *nomparel* by the old English printers. [TYPE.]

Nonsuit. In Law, the renunciation of a suit by the plaintiff. It is either adjudged, in consequence of certain neglects or delays in the prosecution of the suit, or it is voluntarily elected by the plaintiff. It is usual to call on the plaintiff, when he is unable to make out a case to support his pleadings in default of the necessary evidence and the jury are about to give their verdict, to elect, if he pleases, to abandon his prosecution and submit to a nonsuit, upon payment of costs. The effect of this is, that as a nonsuit is not, except in certain cases, a peremptory bar, he is able to bring another action afterwards for the same cause. *Judgment as in case of a nonsuit* arose from the statute 14 Geo. II. c. 17, which enacted that where the plaintiff had neglected to bring the issue to be tried, the court might, unless it saw reason for allowing the plaintiff further time, give judgment for the defendant as in case of a nonsuit, which had the same force as a nonsuit, both as to costs and as to its effects on the action; but this statute was repealed by the Common Law Procedure Act, 1852, which provides that the defendant may sign judgment for his costs where the plaintiff neglects to proceed to trial, unless the time for proceeding to trial is extended by the court or a judge.

Nontronite. A hydrated tersilicate of iron, occurring in France, at Nontron, in the department of the Dordogne. It is found in small kidney-shaped masses, varying in colour from green to yellow, and with a dull lustre.

Nooth's Apparatus. A series of three glass vessels, placed vertically, for the purpose of impregnating water with carbonic acid gas. The lower vessel contains the marble and dilute acid for the evolution of the gas; the central vessel holds the water through which it is made to pass, under the pressure of the column of water in the third or upper vessel, which is closed by a heavy conical stopper, serving as a safety valve. This form of apparatus has been superseded by the comparatively modern and more effective *gasogene*.

Nopal. One of the names of *Opuntia vulgaris*. The allied species, *O. coccinellifera*, is one of the plants upon which the cochineal insect chiefly breeds, another being *Opuntia Tuna*.

Noraghe. The name of a singular class of monuments found in great numbers in the island of Sardinia, about the origin and the uses of which antiquarians are at present much divided. The noraghe are generally built upon a circular or elliptical plan, and have the form of a truncated cone; access is gained to the interior by a door situated towards the south-east, which leads to a corridor communicating with two ranges of chambers, before reaching the central tower. There are four classes of noraghe; the *simple* ones, resembling isolated towers; the *collective*, composed of several united bodies of this class; the *united*, consisting of a large enclosure in the same style of construction, usually upon the top of a hill; the *surrounded* noraghe, or those encircled by exterior works, like a kind of fortress. There are said to be as many as three thousand noraghe in Sardinia; the best account of them is to be found in Della Marmora's *Itinéraire de l'Ile de Sardaigne*, Turin 1860, in which the various theories as to their origin are discussed. They are probably sepulchral monuments, erected in memory of a distinguished leader or chieftain.

Norbertines. [PRÆMONSTRATENSIANS.]

Nordhausen Acid. A peculiar sulphuric acid, intermediate between the anhydrous and monohydrated acid, so called from the place

where it was formerly manufactured. It is generally in the form of a brown fuming liquid. It is a good solvent of indigo.

Norm. [INTEGER.]

Normal (Lat. norma, *a rule*). The normal to a curve is any perpendicular to the tangent erected at the point of contact. At every point of a curve, therefore, there are innumerable normals, all of which are situated in the *normal plane of the curve.* The most important of these normals, however, are the *principal normal*, which lies in the osculating plane, and the *binormal*, which is perpendicular to that plane and, consequently, to the *two* consecutive tangents which the plane contains. In plane curves, where all osculating planes coincide, the principal normal is the only one considered, so that it is not necessary to distinguish it by the term *principal*. Two consecutive normals of a *plane curve* intersect in a point which, being equidistant from three consecutive points of the curve, is the centre of the osculating circle (circle of curvature); the angle between two consecutive normals (angle of curvature) is obviously equal to the angle between the corresponding tangents (angle of contact or contingence). The normals of a curve envelope a second curve (the *evolute*), which is the locus of the centres of curvature of the original one. In non-plane curves this is not the case, for two consecutive principal normals do not intersect one another. The point, however, in which any principal normal is intersected by the next succeeding *normal plane*, is equidistant from three points of the curve, and is consequently the centre of an osculating circle. This is, in fact, the circle of absolute curvature; it lies in the osculating plane, and has its centre on the polar line. The locus of the centres of absolute curvature, therefore, is a curve on the polar developable, but it does not belong to the series of evolutes which this surface contains, since all evolutes are formed by *intersecting* consecutive normals. [EVOLUTE.]

The *normal to a surface* is the perpendicular to the tangent plane erected at the point of contact. Any plane through it is called a *normal plane of the surface.* Two consecutive normals to a surface do not, in general, intersect each other; in fact, a normal is intersected by only two of all the consecutive normals, and the normal planes which contain these intersecting normals are always at right angles to each other; they contain also the tangents to the two lines of curvature which pass through the point on the surface. [CURVATURE, LINE OF.] The methods of finding the equations of normals to curves and surfaces, are given in all treatises on the geometrical applications of the differential calculus.

NORMAL. In Botany, an adjective signifying that the ordinary structure peculiar to a family, a genus, or a species, is not departed from.

Normal School. [SCHOOL.]

Norman Architecture. [ARCHITECTURE.]

Norns. In Scandinavian Mythology, the three Fates, equivalent to the Moirai of the Greeks. [MOIRA.] Their names were Urd, Wörand, and Skuld; or *Past*, *Present*, and *Future*. They were represented as endowed with great beauty, but of a melancholy and sombre disposition; they were consulted even by the gods, and their decrees were sure and irrevocable.

Norroy. [KING-AT-ARMS; HERALD.]

North (Ger. nord). In Geography, one of the four cardinal points of the horizon; that which in European latitudes is opposite the sun at midday.

North-West Passage. A channel along the northern extremity of North America, long believed to be available for commercial purposes. The existence of such a passage has been proved in various ways, and lastly by the expedition in which Franklin and his associates were lost after making their way between the termination northwards of the American land and the southern extremity of the ice of the North Polar Sea. The many expeditions organised to prove the existence of this channel were very fertile in geographical discovery, and have succeeded in showing that for commercial purposes there was no passage of the kind.

Northern Lights. The name popularly given to the *aurora borealis.*

Northing. In Navigation, the difference of latitude made by a ship in sailing northwards.

Nose (Lat. nasus, Fr. nez). The fleshy protuberance, which contains the external cartilages serving to receive the sensation of smell, is so termed in the higher vertebrate animals.

Nosean. A mineral allied to Haüyne, and named after the discoverer, R. W. Nose. It is found in rhombic dodecahedrons in the eruptive rocks of Lake Laach, near Andernach on the Rhine, and in the leucite-rock of Rieden and Volkersfeld in Prussia.

Nosing of a Step. In Architecture, the projecting rounded edges of the tread of a step; it is introduced for ornament, and also to widen the tread.

Nosology (Gr. νόσος, *a disease*, and λόγος). The doctrine of diseases. The term is generally applied to the classification and nomenclature of diseases, and to their general methodical arrangement. [DISEASE.]

Nostalgia (Gr. νοσταλγέω, *to be homesick*). A longing to return home; a disease sometimes observed in a marked degree among the Swiss, the Highlanders, and the Irish. It is well described in Baron Larrey's works. He relates that many of the soldiers under his care were affected by it. The mental faculties early became impaired, and melancholia with severe gastric symptoms terminated the lives of his patients. Between the years 1800 and 1820 as many as ninety-seven French soldiers fell victims to the disease.

Nostrum (Lat.). Literally, *our own*; a term applied to quack medicines retained for profit in the hands of the inventor or discoverer, or of his assignee.

Notables. In French History, the deputies of the states under the old régime, appointed

and convoked on certain occasions by the king. In 1786 this assembly was summoned, 160 years after its last meeting, and proposed various reforms in different branches of the government; it again met, for the last time, in 1788.

Notacantha (Gr. *νῶτος, the back*, and *ἄκανθα, a spine*). The name of a family of Dipterous insects, comprehending those in which the upper part of the thorax or scutellum is armed with teeth or spines.

Notaries, Apostolical and Imperial. Public notaries appointed by the popes and emperors, in virtue of their supposed jurisdiction over other powers, to exercise their functions in foreign states. Edward II. forbade the imperial notaries to practise in England. Charles VIII. of France, in 1490, abolished both these classes of notaries, and forbade his lay subjects to employ them.

Notary or **Notary Public.** In English Law, one who publicly attests documents or writings, chiefly in mercantile matters, to make them authentic in a foreign country; protests foreign bills of exchange, and the like. The statutes 41 Geo. III. c. 79 and 6 & 7 Vict. c. 90 regulate the admission of notaries in England. They must have been apprenticed five years to a notary before such admission.

The name *notary*, among the Romans, appears to have signified a shorthand writer, and to have denoted originally the persons who acted in that capacity, especially at meetings of the senate. Afterwards, the notarii were secretaries to courts, officers, &c. In modern Europe, the notary is an officer whose attestation is necessary to the validity of certain instruments; and his duties are more or less important in different countries. In France the notary is the necessary maker of all contracts, &c., where the subject-matter exceeds 150 francs; and his instruments, which are preserved and registered by himself, are the originals, the parties retaining only copies. The presence and administration of a notary is also essential to the division of lands or goods on inheritance.

Notation, Chemical. A symbolical language employed to express the composition of substances and the changes which occur in chemical processes.

The only symbols employed by the alchemists which appear to have had a fixed meaning were the astrological signs for the metals; and even in the time of the earlier chemists, when other similar signs were added to denote new substances, symbols fulfilled no other purpose than that of convenient abbreviations for names. The first attempt to arrange such symbols in a systematic manner was a plan proposed by Lavoisier in 1782, by which he represented the quantities of substances in addition to the substances themselves. Dalton's completion (in 1804) of the discovery of the fixed laws according to which elements combine, and the introduction of the atomic theory, produced a total change in the principles of chemical notation. From this time each element was denoted by a special sign, which at the same time represented a quantity by weight proportional to the weight of a single atom. [ATOMIC THEORY; EQUIVALENT.] In 1815, after accurate determinations of the combining numbers of the elements, Berzelius proposed a system of notation which, with some modifications, has become completely identified with the pursuit of chemistry. This system in its more modern form we now proceed to describe.

Each element is designated by the capital letter of its Latin name, and in the case of the less important elements the most characteristic letter of the word is added as a further distinction. These symbols are moreover made to represent not only the element itself, but also that proportion by weight in which it invariably enters into combination. For a list of these symbols and combining numbers, see CHEMICAL NOMENCLATURE. Mere addition of one substance to another is denoted by the sign +; but combination is expressed by the juxtaposition of the symbols. Thus water upon this plan is HO, or is composed of one part by weight of hydrogen to eight parts of oxygen. When an element enters into combination in a quantity that is a multiple of its combining proportion, this is expressed by writing the corresponding number on the right a little below the symbol, or else prefixing it in the manner of a coefficient: thus, teriodide of phosphorus, PI_3. Combination between compound bodies is expressed in a similar manner, or a comma is sometimes interposed. A number standing before a continuous group of symbols signifies the multiplication of the whole group by that number. Sometimes a group is enclosed in a bracket with the same object. The following are examples:—

Sulphate of iron, FeO,SO_3, or $FeSO_4$.

Tribasic phosphate of lime, $3CaO,PO_5$, or Ca_3PO_8.

Basic carbonate of zinc, $2(ZnO,CO_2)$, $3(ZnO,HO)$.

The changes which take place in chemical reactions are usually represented by equations. The substances existing before the reaction are placed on the left of the sign =, and those resulting from it on the right. Thus the action of common salt on a solution of nitrate of silver with the production of chloride of silver and nitrate of soda is expressed by

$$AgO,NO_5 + NaCl = AgCl + NaO,NO_5.$$

This equation affirms moreover that from 170 parts of nitrate of silver and 58½ parts of salt, we obtain 143½ of chloride of silver and 85 of nitrate of soda.

Within the last few years certain new views entertained by chemists respecting chemical combination and the construction of compound bodies, have led to some important alterations in the atomic weights represented by the symbols, whereby the formulæ for most substances have become altered. These alterations constitute the chief features of what is called

the *new notation*. In order that the symbols may more perfectly represent the true combining proportions of the elements which they denote, the new notation requires that the atomic weights of oxygen, sulphur, selenium, carbon, silicon and most metals should be doubled. The reasons for these alterations can be best illustrated by shortly stating the chief of those concerned with the doubling of the atomic weight of the most important, viz. oxygen. 1. Physical considerations render it highly probable that equal bulks of elementary gases and vapours contain an equal number of atoms. 2. When hydrogen and oxygen unite to form water, *two* volumes of the former combine with *one* volume of the latter. 3. The hydrogen in water can be replaced in two separate portions by other elements, such as potassium, sodium, and chlorine. 4. When water is generated by decomposition from other substances, the quantity is always such that it contains either two atoms or a multiple of two atoms of hydrogen. The foregoing considerations indicate that the smallest quantity of water ever engaged in a chemical reaction is composed of two atoms of hydrogen united with *one* atom of oxygen, and the atomic weight of the latter must therefore be 16. Again, when oxygen forms a series of combinations with a compound body, each additional quantity of oxygen combining with the latter is always sixteen parts or some multiple of sixteen parts. Furthermore, the specific gravities in the gaseous condition of nearly all elements capable of assuming that condition are proportional to their atomic weights. But if the specific gravity of hydrogen be called 1, then the specific gravity of oxygen is found to be 16. The foregoing reasons, therefore, lead to the adoption of the atomic weight 16 for oxygen. Consequently, water must be represented by $H_2Θ$ instead of HO. The doubling of the atomic weights of other elements either follows from direct analogy, or is supported by similar facts. The doubled atomic weights are often distinguished by a mark through the symbol, as above.

The application of this notation to the expression of chemical composition, though sometimes involving more complex formulæ, indicates far more clearly the mutual relations of bodies and the decompositions of which they are susceptible. The new formulæ express, with very few exceptions, the elementary composition by gaseous volume as well as by weight: thus H Cl O indicates that hypochlorous acid contains equal volumes of its elements. The formulæ also express, with very few exceptions, the weights of the substances denoted by them, which in the gaseous state occupy equal volumes. A great advantage derived from the employment of the new notation, and which deserves special notice, is the prominent expression it gives to the idea of atomicity. This conception, though clearly recognised in the old notation, required the new to develope it completely. Atomicity may roughly be defined as the capacity possessed by any atom of attaching other atoms to itself. Those elements which combine with one atom of hydrogen, or can replace the latter, atom for atom, in compounds, are called *monatomic*. Those elements whose atoms can attach to themselves two atoms of a monatomic element are called *diatomic*. Thus oxygen requires two atoms of hydrogen to form water $H_2Θ$, or one atom of diatomic calcium to form lime $\text{Ca}Θ$. Similarly carbon is tetratomic in marsh gas $\text{C}H_4$ and carbonic anhydride $\text{C}Θ_2$, while nitrogen is triatomic in ammonia NH_3, and pentatomic in sal ammoniac NH_4Cl. This atomic character of an element is termed its *atomicity*, and is frequently marked by dashes, or Roman numerals, after the symbols. The following is a classification of the elements with their new atomic weights, founded on the atomicities which they manifest in their principal combinations. This atomic character is, however, by no means invariable, since the *atomicity* of an element may vary in its different compounds; but in reference to such variation, it has been remarked, that although a monatomic element may become triatomic or pentatomic, it can never be diatomic, tetratomic, or hexatomic, whilst a diatomic element may become tetratomic, but never monatomic or triatomic. In other words, an odd-atomic element can never become even-atomic, and vice versâ.

Monatomic.

H	1	I	127	Rb	85·5
F	19	Li	7	Cs	133
Cl	35·5	Na	23	Tl	203
Br	80	K	39	Ag	108

Diatomic.

O	16	Cd	112	U	120
S	32	Hg	200	Cr	52·5
Se	79·5	Pb	207	Mn	55
Te	129	G	9	Fe	56
Mg	24	Yt	64	Co	59
Ca	40	Ce	92	Ni	59
Sr	87·5	La	92	Cu	63·5
Ba	137	Dy	96	Al	27·5
Zn	65				

Triatomic.

N	14	Sb	122	Bi	210
P	31	Au	197	B	11
As	75				

Tetratomic.

C	12	Cb	195	Ir	197
Si	28	Th	238	Os	199
Sn	118	Rh	104	Mo	96
Ti	50	Ru	104	Va	137
Zr	89·5	Pd	106·5	W	184
Ta	137·5	Pt	197		

The theory of types forms a valuable addition to chemical notation, and owes its developement mainly to the new system. According to this theory, a large number of bodies of complex character are considered to be formed on the plan or model of certain compounds of simple character, from which they are assumed to be derived by substitution. The principal types used by chemists are the hydrogen, water, ammonia, carbonic anhydride,

chloride of ammonium, and chloride of sulphuryl types.

Hydrogen Type.

Hydrogen	Chloride of Ethyl	Acetone
$\left.\begin{matrix}H\end{matrix}\right\}$	$\left.\begin{matrix}C_2H_5\\Cl\end{matrix}\right\}$	$\left.\begin{matrix}C_2H_3\Theta\\CH_3\end{matrix}\right\}$

Water Type.

Water	Alcohol	Acetate of Sodium
$\left.\begin{matrix}H\\H\end{matrix}\right\}\Theta''$	$\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}\Theta''$	$\left.\begin{matrix}C_2H_3\Theta\\H\end{matrix}\right\}\Theta''$

Ammonia Type.

Ammonia	Potassamide	Trimethylphosphine
$N'''\left\{\begin{matrix}H\\H\\H\end{matrix}\right.$	$N'''\left\{\begin{matrix}K\\H\\H\end{matrix}\right.$	$P'''\left\{\begin{matrix}CH_3\\CH_3\\CH_3\end{matrix}\right.$

Carbonic Anhydride Type.

Carbonic Anhydride	Phosgene Gas	Methylic Alcohol
$C^{iv}\left\{\begin{matrix}\Theta''\\\Theta''\end{matrix}\right.$	$C^{iv}\left\{\begin{matrix}\Theta''\\Cl\\Cl\end{matrix}\right.$	$C^{iv}\left\{\begin{matrix}H\\H\\H\\\Theta H\end{matrix}\right.$

Chloride of Ammonium Type.

Chloride of Ammonium	Nitric Acid	Hydrochlorate of Aniline
$N^{v}\left\{\begin{matrix}H\\H\\H\\H\\Cl\end{matrix}\right.$	$N^{v}\left\{\begin{matrix}\Theta''\\\Theta''\\\Theta H\end{matrix}\right.$	$N^{v}\left\{\begin{matrix}C_6H_5\\H\\H\\H\\Cl\end{matrix}\right.$

Chloride of Sulphuryl Type.

Chloride of Sulphuryl	Sulphuric Acid	Chromate of Potassium
$S^{vi}\left\{\begin{matrix}\Theta''\\\Theta''\\Cl\\Cl\end{matrix}\right.$	$S^{vi}\left\{\begin{matrix}\Theta''\\\Theta''\\\Theta H\\\Theta H\end{matrix}\right.$	$Cr^{vi}\left\{\begin{matrix}\Theta''\\\Theta''\\\Theta K\\\Theta K\end{matrix}\right.$

The following are examples of chemical compounds formulated according to both methods of notation:—

	Old	New
Nitric acid . .	$HO.NO_5$	$HN\Theta_3$.
Cyanic acid . .	$HO.C_2NO$	$HCN\Theta$.
Perchlorate of potassium .	$KO.ClO_7$	$KCl\Theta_4$.
Oxalate of lead .	$(PbO)_2.C_4O_6$	$PbC_2\Theta_4$.

Notation, Mathematical. Mathematical notation embraces symbols of *number*, *quantity*, and *operation*. Although the origin of our present system of numerical notation is unknown, there is no doubt that it was in use amongst the Hindus two thousand years ago. Its distinctive feature, i. e. symbols having local as well as intrinsic values [ARITHMETIC], implies a state of high civilisation at the period of its invention. The first numerical symbols consisted probably of strokes or notches cut in wood or stone, and intelligible alike to all nations. Such characters, in fact, are preserved with little alteration in the Roman notation, an account of which may be found in Leslie's *Philosophy of Arithmetic*.

The numeral notation of the Greeks, though far less convenient than that now in use, was formed on a perfectly regular and scientific plan, and could be used with tolerable effect as an instrument of calculation, to which purpose the Roman system was totally inapplicable. The Greeks divided the twenty-four letters of their alphabet into three classes, and, by adding another symbol to each class, they had characters to represent the units, tens, and hundreds. (Delambre's *Astronomie Ancienne*, t. ii.)

Letters of the alphabet are now used as symbols of quantity; and although much diversity exists with respect to the choice of letters, there are several universally recognised rules. Thus in the theory of equations the first letters of the alphabet denote known coefficients, the last letters the unknown terms. In algebraic geometry, again, a similar rule is observed, the last letters of the alphabet there denoting the *variable* or *current* coordinates. Certain letters, such as π, e, &c., are by universal consent appropriated as symbols of the frequently occurring numbers 3·14159 . . . and 2·7182818 . . . . &c., and their use in any other acceptation is avoided as much as possible.

Letters, too, are employed as symbols of operation, and with them other arbitrary characters, such as $+$, $-$, $\times$, $\div$, $\surd$, &c. . . The letters $d, \int$ are appropriated as operative symbols in the differential and integral calculus, Δ and Σ in the calculus of differences, and so on.

In *functional notation*, a letter, as a symbol of operation, is usually combined with another which is regarded as a symbol of quantity. Thus $F(x)$ denotes the *result* of the performance of the *operation* F upon the *subject* x. If upon this result the same operation were repeated, the new result would be expressed by $F[F(x)]$, or more concisely by $F^2(x)$, and so on. The quantity x itself may be regarded as the result of the same operation F upon some other function; the proper symbol for which is, by analogy, $F^{-1}(x)$. Thus F and F^{-1} are symbols of *inverse operations*, the former cancelling the effect of the latter on the subject x. $F(x)$ and $F^{-1}(x)$ in a similar manner are termed *inverse functions*.

The history of mathematics shows that improvements in notation have not only been the result of deeper mathematical insight, but the means by which most important discoveries have been made; in short, that a well-chosen system of notation is of the highest importance to science. Our recent progress in algebra and algebraic geometry is due, to a great extent, to the increased power acquired by the cultivation of more symmetrical and concise methods of notation. The notation of determinants and that of quantics, although of quite modern origin, has already done good service.

Notchboard. In Architecture, the board that receives the ends of the steps in a staircase is so called, because it is notched out to

receive the ends of the steps; the wall string is sometimes the notchboard.

Note (Lat. nota, *a mark*). In Music, a character by which musical sounds are marked, as well as the swiftness or slowness of their motions.

Notes (Lat. notæ). In Literature, originally marks affixed, by the critics who reviewed the works of an author, to those places which they considered to be spurious or faulty, or which on any other account were worthy of remark. In modern times the meaning of the term has been enlarged, being now used as synonymous with *annotation* or *commentary*. Among the Romans, praiseworthy passages were usually marked with LL. (i.e. laudabiles loci); and faulty passages indicated by θ (Per. *Sat.* iv. 12), borrowed from the practice of the judges, who set their mark against those whom they adjudged worthy of death (θάνατος). Good passages were also marked χ, for χρηστός, *excellent*.

NOTES. In Printing, notes are of three kinds: (1) shoulder notes—these are at the top of the page in the outer margin, and contain the book, chapter, or date; (2) side notes or marginal notes, which give an abstract of the text, as in Acts of Parliament, or parallel passages, and different readings, as in the Bible; and (3) bottom notes, or foot notes, which are placed at the bottom of the page, and generally contain commentaries and explanatory annotations.

Notelæa (Gr. νότος, *the south*, and ἐλαία, *the olive*). An Australasian genus of *Oleaceæ*, one species of which, *N. ligustrina*, is the Tasmanian Ironwood, so called from the hardness and density of its wood, which does not, however, attain large size.

Nothing. In Mathematical language, the term *nothing* is of frequent occurrence, and denotes either the absence of magnitude in circumstances in which magnitude might have existed, or it denotes the limit to which a variable magnitude approaches by continual diminution.

Nothing, Differences of. [DIFFERENCES OF ZERO.]

Nothosaurus (νόθος, *illegitimate*, and σαῦρος, *lizard*). A genus of Sauropterygian reptiles from the Triassic (muschelkalk) deposits of Germany. It offered much analogy to the genera *Simosaurus* and *Plesiosaurus*. The *Nothosaurus mirabilis*, from Bayreuth, gives the earliest indication of the modification of the trunk bones, which reaches its maximum in the more specialised *Sauropterygia*, *Plesiosaurus*, and *Pliosaurus*.

Notice. In Law, that notice by which a party is supposed to communicate, or to receive, the presumed or real knowledge which is necessary to affect the receiver with legal liabilities. For instance, when a party purchases or takes a transfer of a debt, he must give notice to the debtor that he has done so, and until such notice is given his title is not complete, for the debtor, if he has no notice of the transaction, may pay his debt to the original creditor, and will be discharged by his receipt. Again, if a creditor assigns his debt to A and B successively, and B gives notice of his own assignment to the debtor before A gives notice of *his*, B shall have priority over A. And the same rule applies to the title to funds vested in trustees and other similar species of property. Constructive notice is that which is presumed to arise from certain facts: as, for instance, in equity, if a purchaser buy land from A in which he knows that B is interested, as mortgagee, tenant, or otherwise, he will be deemed to have constructive notice of the actual extent of B's interest although he may have been misinformed on that point by A, for it is his duty to seek information on the subject from B himself, and in matters of this kind notice to the solicitor or agent is equivalent to notice to the principal.

Notices which pass between landlord and tenant are familiar in practice. Of these the most important is *notice to quit*, which must be given by either party, in the ordinary case of a tenancy from year to year, six months before the termination of the current year of the tenancy; this may of course be varied by written agreement, and is said to be so in some cases by local custom. The reservation of the rent quarterly does not dispense with the necessity for a half-year's notice. If the landlord receives or distrains for rent after serving a notice to quit, it is a waiver of that notice.

Notite. A variety of Palagonite from Val di Noto, in Sicily.

Notodonta (Gr. νῶτος, *back*; ὀδούς, *tooth*). The name of a genus of Lepidopterous insects.

Notonectidæ. [HYDROCORISÆ.]

Nototherium (Gr. νότος, *the south*, and θηρίον, *beast*). A gigantic kangaroo-like animal, which flourished during the pliocene period in Australia. It was undoubtedly herbivorous, and offered many points of analogy to the existing koala (*Phascolarctos*).

Notturno (Ital.). In Music, a term originally synonymous with SERENADE [which see]; but applied at present to a piece of music in which the emotions, chiefly of love and tenderness, are developed. The notturno is a favourite movement with modern pianoforte composers.

Noun (Lat. nomen, *a name*). In Grammar, that part of speech which denotes a *conception*; in contradistinction to an affirmation or judgment, which is expressed by a *verb*. Nouns are divided into substantives and adjectives; the first denoting real or supposed *substances*, the second qualities or properties conceived as belonging to substances. [GRAMMAR.]

Novaculite (Lat. novacula, *a razor*). A stone of which hones are made for sharpening razors. It is of a slaty structure, and owes its quality of giving an edge to the metal to the fine silicious particles which it contains.

Novatians. The followers of Novatianus, a presbyter of Rome, who founded a sect in the third century, which continued to flourish to the end of the fifth. Novatian denied re-

admission into the church to all who, in time of persecution, or on other accounts, had once lapsed from the faith. In this extreme severity he was opposed by the greater number of the clergy of Rome, and especially by Cornelius, upon whose election to the see Novatian, who was a disappointed candidate, withdrew from his communion, and established a society of which he became himself the first bishop. This sect was also known by the title of Cathari, or Puritans, which they assumed to express their high sense of the excellence necessary to Christians.

Novel (Ital. novella, from Lat. novus, *new*). A species of prose fictitious composition.

The Italian novella, of which the best and earliest specimens are contained in the *Decameron* of Boccaccio, was rather a short tale, turning on an event, or on a series of adventures, of humour, pathos, or intrigue, than a novel in the modern acceptation of the term. In its present signification in the English language it seems to express a species of fictitious narrative somewhat different from a romance; yet it would be difficult to assign the exact distinction, and, in the French language, the same name (roman) is used for both; while it differs from a tale merely in the circumstance that a certain degree of length is necessary to constitute a novel.

Although, in fact, the terms *novel* and *romance* are often used indifferently, yet they have often been treated as distinct classes of composition in English literature. It may perhaps be said, that the proper object of a novel is the delineation of social manners, or the developement of a story founded on the incidents of ordinary life, or both together. On this hypothesis, we must exclude from the class of novels, on the one hand, tales of which the incidents are not merely improbable (for this may be the case in a novel), but occurring out of the common course of life, and such as are founded on imaginary times and imaginary manners, tales of supernatural incidents, chivalrous romances, &c.; and, on the other hand, fictitious narratives, in which the author's principal object is neither the story nor the costume, but which are obviously written with an ulterior view. Thus, political, philosophical, and satirical fictions are clearly not to be ranked as novels. But it is obvious that no definition can be drawn which shall, on this subject, entirely satisfy the caprices of popular language.

Of the novel, in this confined sense, the works of Richardson, and those of Fielding and Smollett, afforded, perhaps, the first examples in English literature. The first of these authors gave birth to the sentimental novel, the latter two to the comic or humorous. Marivaux, Prévost, &c. spread the former style of composition in France; where, as well as on the Continent generally, it attained a high degree of popularity. The novel of manners, whether comic or serious, has generally been a more popular species of fiction in England, and has attained, perhaps, its highest amount of popularity in the writings of Dickens and Thackeray.

Novels (Lat. novellæ constitutiones, *new constitutions*). In the Roman Law, supplementary constitutions of some emperors, so called because they appeared after the authentic publications of law made by them. Those of Justinian are the best known, and are commonly understood when the general term is used. The *Novels*, together with the *Code* and *Digest*, form the whole body of law which passes under the name of that emperor.

November (Lat. from novem, *nine*). The eleventh month of the Julian year; but the ninth month in the old Roman year, which began with March. [Calendar; Year.]

November Shower. [Meteors, Luminous.]

Novensiles (Lat.). Certain Latin gods, who are also called Novensides. The first part of the word has been thought by some to be *novem*, nine; by others, *novus*, new. Hence the word has been taken as a name for the nine Muses, or, with more reason, for gods newly introduced (as after the conquest of a place), in contrast with the dii indigetes, or old gods of the country.

Novi Homines (Lat. *new men*). Among the Romans, such persons as, by their own personal merit, had raised themselves to curule dignities without the aid of family connections. [Nobility; Noble.]

Novice (Lat. novitius, *new*). A person admitted into a religious community as an inmate for the purpose of preparation for becoming a member. The state of preparation is termed *novitiate*. The custom of giving novices the religious dress did not begin until the twelfth century. The age of profession is fixed by the council of Trent at sixteen years. During the period of the novitiate the novice is still at liberty to relinquish his intention.

Nox (Lat.; Gr. νύξ). In Mythology, the goddess of night, daughter of Chaos, sister of Erebus, *darkness*, the mother of Æther, *air*, and Hemera, *the day*.

Noyades (Fr. noyer). The name given to a peculiar punishment resorted to in the first French revolution. The *noyades* were effected by drawing out a plug inserted in the bottom of a boat in which the wretched victims were launched. The genius of iniquity, says a writer in the *Edinburgh Review*, often displays itself in the same invention. When Nero wished to kill his mother, Anicetus proposed to him to place her in a ship so framed as to open in part and deposit her in the sea. (Tac. *Ann.* lib. xiv. 3.)

Noyau (Fr.). A liqueur flavoured by bitter almonds, or the kernels of peach stones.

Nucleus (Lat. dim. of nux, *a nut*). In Astronomy, the solid part or body of a comet, as distinguished from its nebulosity. [Comet.]

Nucleus. In Botany, the central fleshy pulpy mass of an ovule; or that part of a seed which is contained within the testa, and con-

sists of either the embryo and albumen, or of the embryo only. In lichens, this word is applied to the disc of the shield, which contains the sporules and their cases. In the language of the older botanists, that which is now termed by gardeners *a clove*, i.e. the secondary bulb of a bulbous plant, was called a nucleus.

Nucule (Lat. nux, *a nut*). In Botany, either that fruit which is otherwise called a gland or acorn, or any small, hard, one-seeded pericarp. The female organ in *Chara* is also called a *nucule*.

Nu[illegible]**seæ.** A suborder of the *Cruciferæ* in which the silicules are one-celled from the absence of a replum, and often contain but a single seed. *Isatis* furnishes an illustration.

Nude or Naked Contract. In Law, a contract without any consideration for it, on which no action lies (ex nudo pacto non oritur actio).

Nudibranchians (Lat. nudus, *naked*; branchia, *gills*). The name of an order of hermaphrodite Gastropodous Molluscs which have the branchiæ exposed on some part of the back.

Nudipedalia (Lat. nudipedalis, *barefooted*). A religious ceremony among the Greeks, Romans, and other nations, observed on account of some public calamity, as famine, drought, pestilence, when women appeared with the feet uncovered.

Nudities. In the Fine Arts, figures either wholly or in part divested of drapery.

Nuggets. The name given in California and Australia to the larger lumps of gold occasionally found in the gold alluvium of those countries and elsewhere. Smaller lumps are called *pepitas*, and the finest particles *granos* or gold grains. Nuggets have been found of extraordinary dimensions and weight; but, as may be supposed, they are comparatively rare. They are always water-worn.

Nuisances (from Lat. nocere, *to hurt*). In Law, nuisances are of two kinds: public or common, which annoy the king's subjects in general; and private, which are defined 'anything done to the hurt or annoyance of the lands, tenements, or hereditaments of another.' The general remedy for public nuisances is by indictment or presentment; for private nuisances, by action for damages. In either case, the Court of Chancery will grant an injunction against the continuance of the nuisance; and this remedy is now commonly resorted to.

Nullah. The name given by the Hindus to small rivers or streams.

Nullipores (Lat. nullus, *none*; porus, *a pore*). The name of a family of Lithophytous Polypes, the axis of which presents no visible pores on its surface.

Nullity of Marriage, Suit for. In Law, this suit is instituted for the purpose of obtaining a sentence in the Court of Matrimonial Causes declaring a marriage void which, without such sentence, is voidable only. [MARRIAGE, LAW OF.] Also, sometimes where a marriage is actually void from the circumstances under which it was contracted, in order to procure a solemn judicial declaration to that effect.

Number (Lat. numerus). Number is defined by Euclid to be an assemblage or collection of units or things of the same species. This definition excludes the unit itself, or 1. Newton defines number as the abstract ratio of one quantity to another quantity of the same species; and hence there are three kinds of numbers, namely, integers, fractions, and surds. Number, abstractedly considered, conveys merely the notion of *times* or *repetitions*. Mathematicians consider numbers under different points of view, or with relation to different properties; and hence arise the various distinctions which have been introduced, as even or odd, whole or fractional, rational or irrational, perfect or imperfect, prime or composite, abundant or defective, simple or complex, &c. Numbers also acquire various denominations from the manner in which they are composed; as TRIANGULAR NUMBERS, PYRAMIDAL NUMBERS, POLYGONAL NUMBERS, &c.

Number. In Metaphysics. [SPACE.]

Numbers of Bernoulli. [BERNOULLI'S NUMBERS.]

Numbers, Theory of. By this name it is customary to distinguish that branch of Mathematics which, transcending ordinary arithmetic, is concerned principally with the theory of congruences and the theory of homogeneous forms, both of which theories are closely connected with the solution of indeterminate equations. In a work of the present kind, any exposition, however brief, of more than the mere elements of the theory would be out of place. We shall, therefore, limit ourselves here to a reference to some of the best works on the subject, and reserve, for their appropriate places, brief enunciations of a few of the more salient theorems, and short explanations of the more frequently occurring technical expressions.

The standard works on the Theory of Numbers are the *Disquisitiones Arithmeticæ* of Gauss (Lipsiæ 1801) and the *Théorie des Nombres* of Legendre (Paris 1830). Almost every modern mathematician of eminence, however, has contributed more or less to the advancement of the theory. In the collected works of Euler, Gauss, Jacobi, Cauchy, Dirichlet, Lagrange, Eisenstein, Poinsot, and others, numerous memoirs on the subject will be found; whilst the recent mathematical journals and academical transactions contain researches in the same wide field, by all the ablest of living mathematicians. Every student of the Theory of Numbers will do well to consult Professor H. J. S. Smith's excellent 'Reports on the Theory of Numbers,' which commenced in the *Transactions of the British Association* for 1859. He will find the concise and lucid critical history of the subject which is there given, rendered doubly valuable by

copious references to the original sources of information.

Numenia. [NEOMENIA.]

Numenius. The name under which Cuvier separated the curlews, as a distinct genus, from the other *Scolopaces* of Linnæus. They have a beak arcuated like that of the ibis, but it is more slender, and is cylindrical throughout; the tip of the upper mandible extends beyond the end of the lower one, and projects a little downwards in front of it. The toes are palmated at the base.

Numerals. The symbols or characters by which numbers are expressed. [NOTATION.]

Numeration. The primary object of numeration is to find names for the different numbers; and, as there are an infinity of numbers, while the number of words is limited, it became necessary to devise some systematic method of combining a few words, so as to express by means of them any number whatever. It is obvious that when large numbers are to be expressed, the lower scales, as the binary, ternary, &c., would be exceedingly inconvenient on account of the multitude of words that would be required. On the other hand, as a name is required for at least every unit in the scale, a very high scale would be no less inconvenient. In the denary scale, the nomenclature is sufficiently convenient, and in our language almost perfectly regular. A name is given to the 9 units of the first order; the unit of the second order is *ten*; and by the different combinations of this word all numbers are named to 99: eleven and twelve are only *apparent* exceptions. A new appellation is wanted for the unit of the third order, or *hundred*. This suffices till we reach the fourth order, or *thousands*; and might even have sufficed to a hundred *hundreds*, or ten thousand. A thousand thousands is called a million, and a million millions a billion; further continuation is useless.

The second object of numeration is to express the nomenclature thus formed by the combinations of a small number of written symbols. This is most conveniently effected by the very refined artifice of giving to each symbol a *local* as well as an *absolute* value. So that the same symbol, 3 for example, is made to express not only 3 *units*, but 3 *tens*, 3 *hundreds*, 3 *thousands* &c.; or 3 *tenth parts*, 3 *hundredth parts*, &c., according to its distance, to the left or right, from the unit's place in any combination of symbols. [NOTATION.]

Numerator. In Arithmetic, that part of the numerical expression of a fraction which indicates how many of those parts into which the unit is supposed to be divided are expressed. Thus, in the fraction $\frac{7}{12}$, the lower number 12 is the denominator, and shows that the unit is divided into 12 parts; 7 is the *numerator*, and shows how many of those parts are to be taken.

Numerical. A term used in Mathematics in opposition to *algebraical* or *literal*. Thus a numerical equation is one whose coefficients are all *expressed* numbers. [EQUATION.] Again, in speaking of the *numerical value* of a quantity, as opposed to its *algebraical value*, the prefixed sign is not regarded. Thus the numerical value of -7 is said to exceed that of -5, although the former has a less algebraical value.

Numida (from Numidia, where, however, this bird was not found). The bird *N. meleagris*, termed *pintado* by the Spanish, and *pearl-hen* and *Guinea-hen* by the English, forms the type of this genus. This bird came originally from the western coast of Africa; and since its introduction into England it has been widely diffused. When transported to Jamaica, it reverts to its original wild condition. Two species of the genus are known, the second (*N. cristata*) inhabiting Southern Africa.

Numismatics (from Gr. νόμισμα, Lat. nummus, *a coin*). The science of coins and medals. The distinction between these classes of objects is, in modern times, that the coin is struck for the purpose of circulation as money; the medal not as a piece of money, but as a token commemorative of some person or event. But ancient coins are often termed, in common language, *medals*. The parts of coin or medal are: the obverse or face, containing generally the head, bust, or figure of the sovereign or person in whose honour the medal was struck, or some emblematic figure in the coins of commonwealths; and the reverse, containing various figures or words. The words around the border of the coin form what is termed the *legend*, those in the middle the *inscription*; when occupying the lower extremity of the pieces, and separated from the rest by a horizontal line, they are termed the *exergue*.

The earliest Grecian coins which we possess appear to have been nearly of a spherical shape. They contain, on the obverse, some emblems of the particular cities which struck them, and on the reverse, deep indentations made by the puncheon in which the metal was held while the obverse was struck. These marks, or the die, were soon brought into a more regular shape, sometimes forming a neat square, sometimes a circle. Types were afterwards introduced on both surfaces of the coin, by inserting some small object in one compartment of the die. Ancient coins have been divided into various historical series, as exhibited in the following table:—

Grecian	1. Civic	Of Græcia Propria and the Of Greek colonies. Of Græco-Asiatic cities.
	2. Monarchic	Kings of Macedon. Kings of states formed out of the Macedonian conquests: Syria, Egypt, &c. &c.; and the independent princes of Epirus and Syracuse.
Roman	1. Consular	Roman asses. Coins of the families.
	2. Imperial	Grecian.—Provinces, Colonies, and Municipia.
	3. Medallions	Grecian. Roman.
Barbarian	1. European: of Thrace, &c.	
	2. Asiatic; of Persia, &c.	
	3. African.	

The objects on Grecian civic coins are either, 1. the emblems of the cities; 2. figures of deities, and their attributes; 3. miscellaneous or general symbols, usurped by many states and cities, usually consisting of warlike objects. The legends on Greek republican coins are either the name of the city or its initial letters; or monograms, i. e. figures forming a portion of the name, in which the characters are so interlaced that a limb of one applies to many.

The earliest coins which bore the heads of princes were those of Macedon, commencing with Alexander the Great, and closing with the extinction of the dynasty of the Lagidæ in the Augustan age. Four principal series of Grecian monarchical coins (either of Greek states or such as adopted the Greek language and customs) have been formed: 1. Of Macedon; 2. Of Sicily, Caria, Cyprus, Heraclea, Pontus; 3. Of Egypt, Syria, the Cimmerian Bosphorus, Thrace, &c. &c., from the era of Alexander the Great down to that of Christ; 4. Of dynasties which flourished subsequently to the latter era; including some kings of Thrace, Bosphorus, and Parthia, with those of Comagene, Edessa, Judæa; to which may be added some lines of Romanised monarchs, as those of Mauritania. The most beautiful monarchic series are those of the Seleucidæ in Syria, and of the Ptolemies in Egypt. The unit of the Grecian silver coinage, in point of value, may be considered as the drachma, which is of a size between our sixpence and shilling; the smallest silver coin is the dichalcos, only $\frac{1}{24}$th of the drachma; the largest, the tetradrachma, containing four drachmæ. The commonest gold coin is the didrachma, weighing two silver drachmæ, and in value 20*s*. or 15*s*. sterling. Grecian copper coins are generally small.

The Roman coinage differs from the Grecian in many respects; the greater size of the copper coins in early times, and their superior workmanship in later, the prevailing simplicity of devices, &c., form characteristic marks of difference. In the first period of the republic they were cast. The consular copper coins have separate symbols for the pieces, according to their respective value; as the head of Janus for the *as*, Jupiter for the *semis*, &c. The *as* also bore the impress 1, to denote its quality of unity as a measure of value. The name *family coins*, applied to many coins of the republic, arose from the custom of inserting the name of some distinguished family in the field of the coins. A silver coinage was first introduced into Rome 226 B. C. The oldest coin was the denarius, equivalent to ten asses: the earliest of these have the head of Janus, for which that of Rome was afterwards substituted on the obverse, with a variety of symbols on the reverse. The coinage of gold was introduced into Rome sixty years after that of silver: the pieces were—the scrupulum, one-third of the denarius in weight; a coin weighing two-thirds; and another weighing a whole denarius. Afterwards the chief gold coin was the *aureus* (twice the weight of the denarius). The imperial Roman coins form by far the most complete and varied series which we possess of ancient or modern times. The symbols on the reverse have been arranged under four heads: as relating to religion, war, games, and the embellishments of the city, under the numerous subdivisions of these subjects. The obverses contain the portraits of emperors and empresses. The characters on the reverses of the coins are, generally speaking, explanatory of the type; expressing in a few brief words the history of some occurrence immediately after which the coin was struck, &c. The legends on the obverse mostly contain titles annexed to the imperial dignity, often expressed in abbreviations productive of not a little obscurity.

Not less than three hundred portraits are preserved in the series of Roman imperial coins. The term *medallion* is applied to those productions of the Roman or provincial mints which, in gold, exceed the size of the aureus; in silver, of the denarius; in copper, of the largest copper coin of ascertained value. It is doubtful whether they were intended for circulation as coins, or struck, like medals among ourselves, as commemorative tokens.

Modern coins present so wide a variety as to render it impossible to include any classification of them within the limits of the present notice. In Britain, Roman coins were current until the arrival of the Saxons: we have the coins of five out of the seven kingdoms of the heptarchy; among them some small copper coins, the only specimens of that metal coined before the reign of Elizabeth. Coins struck prior to the reign of Charles II. had their devices impressed by the blows of a hammer. The system of lettering on the edges, which was succeeded by graining, was devised in order to obviate the fraudulent practice of clipping and filing the current coin.

Nummulites. An extinct genus of foraminiferous Acrites, of a thin lenticular shape, divided internally into small chambers. These occur so abundantly in some parts of the chalk formation, that the name of nummulitic limestone is given to the strata so characterised.

Nummulitic Formation. A very remarkable series of limestones, often of great thickness, containing a peculiar fossil, the NUMMULITE, in incredible abundance, belonging to the middle division of the lower tertiaries, and ranging more widely than any known tertiary rock. They reach from China by the Himalayan Mountains to the mouths of the Indus, thence by Persia to the Mediterranean, entering largely into the Carpathian and Alpine mountain masses, extending through the South of France to the Pyrenees, and thence across to the south of Spain and the north of Africa. In the Alps the nummulitic beds are called FLYSCH [which see]. As a single group of deposits characterised uniformly by the same fossils, the nummulitic formation is certainly the most widely spread of all the tertiaries; and although not represented in England in precisely the same

form as elsewhere, the foraminiferous fossils of the London clay are doubtless of the same date.

So widely distributed are these deposits, that they extend over an area measuring no less than twenty-five degrees of latitude and 100 degrees of longitude in extent. In Western Thibet they have been found 16,500 feet above the level of the sea. In China they are met with, and they are known throughout Eastern Bengal.

Nuncio (Ital. from Lat. nuntius, *a messenger*). An envoy of the pope to the court of an emperor or king to negotiate ecclesiastical affairs. [LEGATE.] Before the council of Trent the papal nuncios acted as judges in the first instance of matters which lay within ecclesiastical jurisdiction; but since that time they have formed a kind of court of appeal from the decisions of the respective bishops. This jurisdiction, however, holds good only in those countries which still hold themselves subject to the decretals and discipline of the council of Trent; for in other kingdoms and states, such as France, Austria, &c., which, though Roman Catholic, hold themselves independent of the Roman pontiff in matters of discipline, the papal nuncio has no jurisdiction whatever, and is invested merely with a diplomatic character, like the ambassadors of any secular power. In 1863 the court of Rome had, nominally, twelve nuncios in different countries; but several of those were attached to the small Italian courts, abolished by the union of Italy.

Nuncupative Will (Lat. nuncupo, *I name*). In Law, a will orally delivered by the testator. By English law, however, all wills must, as a general rule, be in writing, and executed with certain prescribed formalities; but an exception prevails in some cases and for some purposes in favour of soldiers on an actual military expedition and of seamen at [WILL.]

(Lat.). The market-days or fairs at Rome were so called, because they recurred every ninth day. On this day the people from the country and the neighbouring towns flocked to Rome with the produce of their farms or industry. On that day, also, all public proclamations were made, causes heard, witnesses cited, and judgments given. The nundinæ were *feriæ* or *dies nefasti* for the populus or patricians, while for the plebs they were *dies fasti*; but it is said that this distinction was removed by the *Lex Hortensia*.

Nuns (Ital. nonna). Female devotees among the Roman Catholics, who, like the monks of the other sex, seclude themselves in religious communities.

Among nuns, as among monks, there are various orders; some devoting themselves entirely to contemplation and spiritual exercises, but many others to the more active duties of private and public charity. [MONACHISM; ORDERS, RELIGIOUS; see also the several orders of nuns under their respective heads.]

Nuphar (Arab. noufar). One of the Water-lilies of our streams and rivers. *N. lutea* is the Yellow Water-lily, whose broad orbicular leaves float on the surface of the water, the yellow blossoms with a perfume of brandy (hence called *brandy-bottles*) rising here and there between them. The seeds contain a good deal of starch, and are sometimes used as food.

Nursery. In Gardening, a plot of ground, or an entire garden, set apart for the propagation of plants, more particularly trees and shrubs. The situation ought to be open and airy, and the soil of an average quality, neither too heavy nor too light, so as to be adapted to the majority of plants. In a complete nursery there ought also to be shady borders for plants requiring shade, and beds or compartments of peat soil, or other peculiar soils, for such plants as are not readily propagated and grown in ordinary soils. Where tender plants are propagated, or where hardy plants are to be raised from seeds or struck from cuttings which are not easily germinated or rooted in the open ground and in the ordinary manner, hot-beds, frames, and hand-glasses are also requisite.

Every private garden of any extent requires a nursery to raise and bring forward young plants as a reserve for supplying failures by disease or accident in the general garden; and in every country where private gardens or plantations of trees are frequent, public or commercial nurseries are formed by persons who adopt nursery gardening as a business.

Nussierite. A phosphate of lead and lime with chloride of lead, occurring in obtuse rhombohedrons of a yellowish, greenish, or greyish colour, with a faint waxy lustre, at Nussière, in the department of the Rhône, in France.

Nut (Lat. nux). In Botany, a hard indehiscent pericarp usually containing only one seed. The word *nut* is also applied in popular language to the fruit or kernel of the seed of various plants, some of the more important instances being those of *Moringa pterygosperma*, the Ben-nut; of *Caryocar nuciferum*, the Butter-nut; of *Anacardium occidentale*, the Cashew-nut; of *Castanea vesca*, the Chestnut; of *Cola acuminata*, the Kola-nut; of *Arachis hypogæa*, the Ground-nut; of *Cocus nucifera*, the Cocoa-nut; of *Phytelephas macrocarpa*, the Ivory-nut; of *Semicarpus Anacardium*, the Marking-nut; of *Curcas purgans*, the Physic-nut; of *Strychnos nux vomica*, the Poison-nut; of *Lecythis Zabucajo*, the Sapucaia-nut, and various others.

The name is also commonly applied to the fruit of different species of or hazel. The kernels of these have a mild farinaceous oily taste, agreeable to most palates. A kind of chocolate has been prepared from them, and they have sometimes been made into bread. The expressed oil of hazel nuts is little inferior to that of almonds. Besides those raised at home, nuts are imported from different parts of France, Portugal, and Spain, but chiefly from the latter.

The Spanish nuts in highest estimation, though sold by the name of Barcelona nuts, are not shipped thence, but from Tarragona, whence the annual average export is estimated at from 25,000 to 30,000 bags, 4 to the ton.

Nut of a Screw. In Architecture, a piece of wood, iron, or other metal pierced cylindrically, wherein is cut a spiral groove, adapted to an external cylindrical spiral cut in relief in a bolt. Its use is to screw two bodies together, a head being placed on one end of the bolt to counteract the action of the nut, and to keep the bodies to be connected in contact. Two bodies are thus held together by compression, the bolt between the head and the nut acting as a tie.

Nutation (Lat. nutatio, *a nodding*). In Astronomy, the name given to a small gyratory movement of the earth's axis, in virtue of which, if it subsisted alone without the precession of the equinoxes, the pole of the equator would describe among the stars, in a period of about nineteen years, a small ellipse, having its longer axis equal to 18·5″, and its shorter one to 13·74″; the longer being directed to the pole of the ecliptic.

In order to understand the nature of this phenomenon, it is necessary to consider it in connection with that of precession, as both depend on the same physical cause, and form, in fact, essential constituent parts of one and the same great phenomenon. The action of the sun and moon on the protuberant mass about the earth's equator tends constantly to draw the plane of the equator towards that of the ecliptic, or to diminish the angle between them. In consequence of the earth's rapid rotation about its axis, the inclination of the two planes is not permanently altered, but a motion is communicated to the plane of the equator, of such a kind that its axis revolves with a slow conical motion about the axis of the ecliptic; or, which is the same thing, the pole of the equator describes a circle in the heavens about the pole of the ecliptic as a centre, keeping constantly at the same mean distance of about 23° 28′ from it. The direction of this motion is from east to west, and its velocity amounts only to 50·1″ annually, so that the whole circle requires for its description a period of 25,868 years.

As the effect of the sun or moon in giving the earth a motion about its centre of gravity varies with the distance of the attracting body from the plane of the equator, it is evident that the effect of the sun is greatest at the solstices, and is reduced to nothing at the equinoxes. On this account, the obliquity of the ecliptic is subject to a small semi-annual variation, depending on the sun alone. This is called the *solar nutation*. Its existence is, however, only a deduction from the theory of attraction; for its amount, which is less than half a second, is too small to be sensible to observation. The result produced by the combined action of the sun and moon is called the *luni-solar nutation*; though the sensible part of it is produced only by the moon, and follows exactly the period of the moon's nodes.

The uranographical effect of the nutation is to produce a periodical fluctuation of the apparent obliquity of the ecliptic, and of the velocity of the retrogression of the equinoctial points. In fact, the circle which the pole of the equator would describe by virtue of precession is by nutation changed into a wavy line. Hence arises the distinction between apparent and mean right ascension and declination; the former being given by direct observation, and the latter being the results obtained when the observed places of objects have been cleared of the periodical fluctuations arising from nutation. Formulæ and tables, for the reduction of observations to a common epoch, are given in all works on practical astronomy. The discovery of the nutation of the terrestrial axis belongs to Bradley, and was a consequence of his other great discovery, the aberration of light.

Nutcracker. A rare British bird of the order *Picæ*, belonging to the genus *Nucifraga*, and termed *caryocatactes* (Gr. καρυοκατάκτης), from its habit of cracking the shells of nuts to obtain the kernel. It is of the size of a jackdaw, but with longer tail. It is not to be confounded with the nuthatch.

Nuthatch. The name of a shy and solitary bird of the genus Sitta (*S. europæa*). It frequents woods, and feeds chiefly on insects; but it also eats the kernel of the hazel nut, which it cracks by fixing it in a chink, and striking it from above with all its force. The nuthatch lays her eggs in holes of trees, and hisses like a snake when disturbed.

Nutmeg. The fruit of the *Myristica moschata* (*officinalis*), a beautiful tree of the *Myristicaceæ*, which grows in the Molucca islands. All the parts of this tree are very aromatic; but only those portions of the fruit called *mace* and *nutmeg* are sent into the market. The entire fruit is a species of *drupe*, of an ovoid form, of the size of a peach, and furrowed longitudinally. The nutmeg is the innermost kernel or seed, contained in a thin shell which is surrounded by the mace; and this again is enclosed in a tough fleshy skin, which opening at the tip separates into two valves. The nutmeg tree yields three crops annually: one in April, which is the best; one in August, and one in December.

Good nutmegs should be dense, and feel heavy in the hand. When they have been perforated by worms, they feel light; and though the holes have been fraudulently stopped, the unsound ones may be easily detected by this criterion.

Nutmegs afford two oily products. 1. Butter of nutmeg, vulgarly called oil of mace, is obtained in the Moluccas, by expression, from the fresh nutmegs, to the amount of 50 per cent. of their weight. It is a reddish-yellow butter-like substance, interspersed with light and dark streaks, and possesses the agreeable smell and taste of the nutmeg from the presence of a

volatile oil. It consists of two fats; one reddish and soft, soluble in cold alcohol; another white and solid, soluble in hot alcohol. 2. The volatile oil known as *oil of mace*, deposits a stearoptene which has been called *myristicin*.

Nutria (Span.). This name for the *Myopotamus Bonariensis* (Commerson), the *Coypú* of Molina, and the *Quoiya* of D'Azara, is derived most probably from some supposed similarity of the coypú, in appearance and habits, to the otter, the Spanish name for which is nutria.

Like the beaver, the coypú is furnished with two kinds of fur; viz. the long ruddy hair, which gives the tone of colour, and the brownish ash-coloured fur at its base, which, like the down of the beaver, is of much importance in hat-making, and the cause of the animal's commercial value.

The habits of the coypú are much like those of most of the other aquatic Rodent animals. Its principal food, in a state of nature, is vegetable. It affects the neighbourhood of water, swims perfectly well, and burrows in the ground. The female brings forth from five to seven at a time; and the young always accompany her. The coypú is easily domesticated, and its manners in captivity are very mild. (Martin, *Proceedings of the Zoological Society*, 1835.)

Nutria fur, largely used in the hat manufacture, has become, within the last fifteen or twenty years, an article of very considerable commercial importance. The imports fluctuate considerably, as many as 600,000 skins having been sometimes imported annually from Buenos Ayres and Chili; but the wars between these states have reduced the exports to about 3,000 skins.

Nutrition. The ultimate and proximate components of the food of animals, and the processes by which it is elaborated in the vegetable world, are subjects which have been elsewhere adverted to [DIGESTION; FOOD]: it only remains to notice a few of the leading points bearing upon the physiology of animal nutrition. It is the business of the vegetable creation to absorb certain substances from the soil and from the atmosphere, and to convert them into parts of themselves. These substances are the media by which *inorganic compounds*, as they are usually termed, are changed into *organic products*; and it is through their functions, and in their structures, that the water, carbonic acid, and ammonia, of the atmosphere, together with various substances derived from the soil, are converted into the innumerable products of the vegetable world. Of these products, such only as are essential parts of the food of animals need be mentioned here; gum, starch, sugar, and fat, for instance, on the one hand, and on the other several albuminoids or azotised substances. But besides these, there are required, for the building up of the frame of the herbivorous or grazing animals, many other substances, which pass from the soil into the plant, and through the plant into the animal; such as various earthy and saline products (compounds containing metals and metalloids) essential to animal growth: so that if we look at the composition of the food of animals, in reference to its *ultimate elements*, we find that the carbon, hydrogen, oxygen, and nitrogen, the sulphur, phosphorus, and chlorine, the lime, soda, potash, &c., which in the form of water, carbonic acid, ammonia, and certain chlorides, phosphates, and sulphates, are taken from the air and from the soil, are elaborated, by processes infinitely beyond our comprehension, into the *proximate components* of the vegetable; and that among these proximate components, thus elaborated, all the essential materials necessary to the growth and sustenance of animals are to be found. The functions of plants, therefore, include the *formation* of a variety of complicated products out of the comparatively simple materials derived from the air which surrounds them, and from the soil in which they are planted. [BOTANY.] The functions of animals, on the other hand, tend to diametrically opposite effects. Their food is, either directly or indirectly, of vegetable origin, consisting exclusively, as far as graminivorous tribes are concerned, of the complex produce of plants; and their functions tend to the progressive and ultimate resolution of these products into water, carbonic acid, and ammonia, and the other comparatively simple or binary arrangements which we set out with as the food of plants; and a plant can no more live upon the complex combinations which are required for the support of animal life, than an animal can live upon the simple binary combinations essential to vegetable life. These wonderful transmutations of inorganic into organic products through the instrumentality of vegetables, and of organic into inorganic products through the instrumentality of animals, must always be borne in mind, in reference to all the phenomena connected with the nutrition of vegetables and animals, and with all that belongs to the influence of soil and climate, and of food and diet, and as lying at the foundation of all agricultural and sanitary improvements.

Chemical physiologists have taught us that the food of animals may be regarded as including two distinct series of proximate principles; namely, those which do not contain nitrogen, and consist of carbon, hydrogen, and oxygen, and which appear to be chiefly concerned in maintaining animal heat, by a species of slow combustion terminating in the production of carbonic acid and water, which are thrown off by the lungs, and are therefore termed *aliments of respiration*; and those which do contain nitrogen, and which, consisting of carbon, hydrogen, oxygen, and nitrogen, with sulphur and phosphorus, are employed in the formation of the principal organs of the body, and which have therefore been called *plastic elements of nutrition*. The former include starch, gum, sugar, and fat; the latter are the nitrogeniferous products of vegetation (such as gluten, legumine, and albumen), and their

congeners, the flesh and blood of animals. With both of these, but more especially with the latter, are associated what have been called the inorganic elements of food, namely the saline and earthy matters. The importance of these distinctions will be more evident when they are considered in reference to the animal functions, which, although essentially the same in the carnivorous and graminivorous tribes, may be most conveniently described in reference to the less complicated machinery of the former; for we are here, of course, obliged to limit ourselves to the higher orders of animals, to the exclusion of the infinite variety of phases which the process of nutrition assumes in the infinitely varied grades of the animal world.

In respect to ourselves, the first operation which the food undergoes is that of mastication, and mixture with saliva; it is then propelled through the œsophagus into the stomach, where *digestion*, as it is called, may be said properly to commence. The food is here gradually brought into the state of a comparatively uniform pulpy mass called *chyme*, and becomes mixed with the gastric juice, which acts upon and modifies the nitrogeniferous or azotised aliments (plastic aliments), but does not materially affect the non-azotised or amylaceous, saccharine, and oleaginous food (respiratory aliments). The gastric juice, in consequence of the peculiar action of the pepsine, and of the acid which it contains, softens and ultimately dissolves the albuminous and fleshy parts of the food. The modified contents of the stomach are then propelled into the small intestines, where they meet with the pancreatic juice, the action of which is principally upon the oleaginous and amylaceous ingredients of the food; it forms a perfect and uniform emulsion with the former, and converts the latter into sugar. In the duodenum, the chyme also becomes mixed with the bile which is secreted by the liver, and which, after having remained some time in the gall-bladder, enters the duodenum by the choledic duct. [CHOLEDOCHUS.] What the exact action of the bile is has not been satisfactorily ascertained, but it is necessary to the formation of perfect chyme, and probably plays some important part in the separation of the excrementitious from the absorbable and nutritive part of the food. The chyme, thus perfected by the joint action of the gastric, pancreatic, and hepatic secretions, is now separated into *chyle* (which is absorbed by the lacteals, and ultimately conveyed into the venous blood, to which it restores the various principles which it had lost in the course of its circulation), and into an unabsorbed residue, which, together with such other matters as may have resisted the action of the digestive process, is transferred to the large intestines, and ultimately voided in the form of excrement.

The respective attributes of the vegetable and animal creations which have been above adverted to, have been contrasted as follows by Dumas and Cahours: —

VEGETABLES			
Produce	Azotised substances. Fatty matters. Starch, gum, sugar.	*Consume*	Azotised substances. Fatty matters. Starch, gum, sugar.
Decompose	Carbonic acid. Water. Ammonia.	*Produce*	Carbonic acid. Water. Ammonia.
Evolve	Oxygen.	*Absorb*	Oxygen.
Constitute an apparatus of *reduction*: are *stationary*.		Constitute an apparatus of *oxidisement*: are *locomotive*.	

Nuttallite. A variety of Scapolite, named after Mr. Nuttall, by whom specimens of the mineral were first brought to this country. It occurs in white rectangular prisms, which are yellowish in some parts and in others bluish or green, at Bolton and Boxborough in Massachusetts, in coarse granular limestone, with Epidote and Titanium ore; also in Lewis county, New York.

Nux (Lat. *a nut*). A kind of fruit, hard, dry, not splitting, and containing only one seed. The term is also extended by some writers to any similar fruit, whether it contains one cell or more than one. [NUT.]

Nux Vomica (Lat.). The fruit of *Strychnos nux vomica*, a shrub growing in the East Indies. It contains the alkaloids strychnia and brucia, and is a virulent poison. [STRYCHNOS; STRYCHNIA.]

Nyctaginaceæ (Nyctago, an old synonym of one of the genera). An order of Monochlamyds belonging to the Chenopodal alliance, containing a small number of plants natives of warm countries, few of them of any importance or beauty save *Mirabilis*, the well-known Marvel of Peru, a very showy plant, the flowers being very fragrant in the evening, and a general favourite in the mixed flower garden.

Nyctalops (Gr. νυκτάλωψ). One who sees distinctly only in twilight, or the dusk of evening. [HEMERALOPIA; NIGHT BLINDNESS.]

Nylghau. The name for one of the largest species of antelopes (*Portax Tragocamelus*), which attains the height of four feet at the shoulder. It has been frequently introduced into our menageries. The horns are about seven inches long, small, round, and black; the pastern joints are marked in front with one white spot, and in the rear with two conspicuous ones of the same colour, which contrast strongly with the dark brown of the surrounding parts and the slaty blue of the rest of the body. It has often bred in confinement, where its vicious and uncertain temper renders it very intractable.

Nymph (Gr. νύμφη, *a nymph*). The Metabolian insects are so called when in the second stage of their metamorphosis, especially when they possess the power of locomotion. [PUPA.]

Nymphs (Gr. νύμφαι). In Greek Mythology, female beings who peopled all the regions of earth and water. They may be divided into two classes, the one representing powers of nature, the other personifying

tribes, races, cities, &c. Among the former, the Naiads inhabited the streams, the Oreads the mountains, the Dryads the woods, the Hamadryads trees, with which they were born and died. The Oceanides were nymphs of the ocean; the Potameïdes inhabited the rivers; the Napææ dwelt in forests, &c. Their number was almost infinite, and they were represented generally in the form of beautiful maidens.

Nymphacea. In Zoology, a name given by Lamarck to a family of Bivalves.

Nymphæa. The Water-lily genus, represented in our native Flora by *N. alba*, one of the most lovely of aquatic plants, known by its almost circular floating leaves, and white rosette-shaped flowers rising amongst them just above the water. In this genus the ovary is embedded in the receptacle, and internally divided into numerous many-seeded compartments. There are many exotic species, varying in character and in the colour of their flowers, which is either white, red, or blue. *N. Lotus*, which has white flowers, is the White Lotus of the Nile.

Nymphæaceæ (Nymphæa, one of the genera). In Botany, a natural order of plants, containing the Water-lilies of various parts of the world; they are polypetalous, polyandrous Exogens, with the sides of the cells of the fruit covered with numerous seeds. Their stems burrow into the mud of the places where they grow, and have slightly astringent narcotic properties. The species are most valued for the beauty of their flowers, which, in *Victoria regia*, are among the largest in nature, measuring as much as four feet in circumference..

Nymphalis. A genus of diurnal Lepidopterous insects, now the type of a family.

Nymphipara (Gr. *νύμφη, a nymph*; Lat. pario, *I produce*). A hybrid name applied by Réaumur to a family of Dipterous insects, and changed by Latreille into PUPIPARA.

Nystagmus (Gr. *νυσταγμός*). A winking of the eyes, as observed in a drowsy person.

O

O. A letter of the vowel series, which, if arranged according to the nature of the sound, occupies a position between *a* and *u*. It is susceptible of numerous interchanges. The Greeks had two forms of this letter, ο (*omicron*, or little *o*), and ω (*omega*, or large *o*); the former of which was equivalent to the short, and the latter to the long pronunciation of this letter in other countries. Among the Irish, the letter O prefixed to a name is equivalent to *Fitz* in England and *Mac* in Scotland, indicating *son*.

O. In Music, the O, or circle, is a note which we call a *semibreve*, the French a *rond*, and the Italians *circolo*.

Oak (Ger. eiche). The general name of a well-known hard-wooded forest tree, much cultivated for the purposes of timber, particularly in shipbuilding, and in other cases when much exposure to the weather is necessary. There are several varieties of this valuable tree (*Quercus Robur*); but the common English Oak, distinguished as *Quercus pedunculata*, claims precedence of every other. The oak timber imported from America is very inferior to that of this country: the oak from the central parts of Europe is also inferior, especially in compactness and resistance of cleavage. The knotty oak of England, the 'unwedgeable and gnarled oak,' as Shakspeare calls it, when cut down at a proper age (from fifty to seventy years), is the best timber known. Some kinds are harder, some more difficult to rend, and some less capable of being broken across; but none possesses all the three qualities in so great or in such equal proportions; and thus, for at once supporting a weight, resisting a strain, and not splintering by a cannon shot, the timber of the oak may be regarded as superior to every other.

A fine Oak is one of the most picturesque of trees: it conveys to the mind associations of strength and duration which are very impressive. The oak stands up against the blast, and does not take, like other trees, a twisted form from the action of the winds. Except the cedar of Lebanon, no tree is so remarkable for the stoutness of its limbs; they do not exactly spring from the trunk, but divide from it; and thus it is sometimes difficult to know which is stem and which is branch. The twisting of the branches of the oak, too, adds greatly to its beauty; and the horizontal direction of its boughs, spreading over a large surface, completes the idea of its sovereignty over all the trees of the forest.

The oak is raised from acorns, sown either where the oak is to stand, or in a nursery whence the young trees are transplanted.

The colour of oak wood is a fine brown, and is familiar to every one: it is of different shades; that inclined to red is an inferior kind of wood. The larger transverse septa are in general very distinct, producing beautiful figures when cut obliquely. Where the septa are small, and not very distinct, the wood is much the strongest. The texture is alternately compact and porous; the compact part of the annual ring being of the darkest colour, and in irregular dots, surrounded by open pores, producing beautiful dark veins in some kinds, particularly in pollard oaks. Oak timber has a peculiar odour, and the taste is slightly astringent. It contains tannic and gallic acid, and is blackened by contact with iron. The young wood of English oak is very tough,

often cross-grained, and difficult to work. Foreign wood, and that of old trees, is more brittle and workable. Oak warps and twists much in drying, and shrinks in seasoning.

Oak of good quality is perhaps more durable than any other wood that attains a like size. Vitruvius says it is of eternal duration when driven into the earth: it is extremely durable in water; and in a dry state it has been known to last 1,000 years. The more compact it is, and the smaller the pores are, the longer it will last; but the open, porous, and foxy-coloured oak, which grows in Lincolnshire and some other places, is not nearly so durable.

The sessile-fruited Oak (*Quercus sessiliflora*), often included with *Quercus pedunculata* under the name of *Quercus Robur*, is pretty abundant in several parts of England, particularly in the north. The wood of this oak is said by Tredgold to be darker, heavier, harder, and more elastic than the common oak; tough, and difficult to work; and very subject to warp and split in seasoning. Mr. Tredgold seems disposed to regard this as superior to the common oak for shipbuilding; but other high authorities are opposed to him on this point. A well-informed writer in the *Quarterly Review*, indeed, remarks that *Quercus Robur* affords a close-grained, firm, solid timber, rarely subject to rot; while that of the *Quercus sessiliflora* is more loose and sappy, very liable to rot, and not half so durable. It may thus be discriminated from the true old English oak: The acorn stalks of the *Robur* are *long*, and its leaves *short*; whereas the *sessiliflora* has the acorn stalks *short*, and the leaves long: the acorns of the former grow singly, or seldom two on the same footstalk; those of the latter in clusters of two or three close to the stem of the branch. We believe that those Russian ships of the Baltic which are not of larch or fir are built of this species of oak; but if this were not the case, their exposure on the stocks, without cover, to the heat of summer (which, though short, is excessive), and the rifts and chinks which are filled up with ice and snow in the long winter, are enough to destroy the stoutest oak, and sufficiently account for their short duration. On the whole, it may be concluded that the durability of oak timber depends more on the nature of the soil, and on the rapidity or slowness of growth, than on the particular variety of which it is the produce.

Oak Apple. A species of gall-nut produced upon oak trees: it is usually spheroidal, and from one to two inches in diameter: its texture is spongy, and it is sometimes employed as a substitute for nut-gall in dyeing.

Oak Leather. A kind of fungus-spawn, found in old oaks, having, when removed, somewhat the appearance of white kid leather. It is sometimes used for spreading plasters on.

Oakum. The fibres of old hempen rope: it is used on shipboard in caulking seams &c. in combination with pitch.

Oannes. In Ancient Mythology, a Babylonian divinity, identified by some with the god Dagon, like whom he had with a human head the body of a fish. But the myth that this monstrous being conversed with men by day, and plunged into the sea by night, suggests a parallel with that of Proteus. In his universal instructions, which embrace the principles of all science, he is the counterpart of the Chinese Fohi and the Egyptian Thoth, or Hermes Trismegistus.

Oar (Norse ar, Esthon. air. The root of this word is AR, *to plough*. Thus Shakspeare speaks of *earing* [i.e. ploughing] the sea with keels. The root is found in the Greek ἀρόω, *to plough*, and ἐρέσσω, *to row*, ἄροτρον, *a plough*, ἐρετμός, Lat. remus, *an oar*). In Nautical Affairs, a long piece of timber, flat at one end, and round or square at the other, by which a boat, barge, or galley, &c. is propelled through the water. The flat part dipped into the water is called the *blade*; the other end is the *loom*, which terminates in the handle. The fulcrum of the oar is the water, at the point of the blade, into which it is dipped, and the resistance offered by the weight of the boat is applied at the gunwale, where the oar is supported by means of the rowlock. The power is the rower's strength acting on the handle and within the boat. The oar is consequently a lever of the second class.

Oar-weed. The large form of *Laminaria digitata*.

Oasis (derived from the Coptic ouah, Arab. wâh). The name given to those fertile spots, watered by springs and covered with verdure, which are scattered about the great sandy deserts of Africa. The most noted are situated in the Libyan desert. The oases of Egypt are nothing more than valleys or depressions of the plain which forms the table-land of Eastern Africa. They resemble, in many respects, a portion of the valley of Egypt, being surrounded by steep cliffs of limestone at some distance from the cultivated land, varying in height in the different oases, those rising from the southern oases being the highest, and all of them being intersected by patches of desert. They owe their origin doubtless to the springs with which they abound, the decay of the vegetation thence arising having produced the soil with which they are now covered. Their fertility has been celebrated; but the eulogiums of travellers on their beauty are in a great measure to be ascribed to the contrast with the deserts by which they are surrounded. It may appear strange that they should have been selected as places of banishment; but that such was the case, at least under the Romans, is certain. A law of the *Digest*, lib. xlviii. tit. 22, refers to this practice; and it has been supposed that the poet Juvenal was one of those who suffered a temporary banishment (*relegatio*) to the oases, though the evidence of this is by no means clear. (*Biographie Universelle*, art. 'Juvenal.') The larger oases have some fine ruins, the most celebrated of which is the temple of AMMON, at Siwah. [DESERT.]

Oast (Dutch ast, *a kiln*). The term applied to a kiln for drying hops, heated by a stove with flues.

Oast House. [HOP OAST.]

Oat (A.-Sax. ata, akin to æt, *food*). The common name of one of the corn-producing grasses commonly cultivated in temperate climates. [AVENA.] The seeds of one species of Oat, *A. sterilis*, have remarkably long hygroscopic awns, by means of which they move forwards, as the awns become expanded or contracted by the influence of drought or moisture. They are hence called *animal oats*.

The Common Oat is *Avena sativa*, of which many varieties are grown. The grain is used for feeding horses; and when ground into a coarse meal, forms a considerable proportion of the food of labouring men in Scotland, Ireland, and the north of England. The grain coarsely broken after the removal of the husk forms grits, an article extensively used in making gruel or invalids' food; and the chaff is made into beds by the poor, and forms a good and wholesome substitute for feathers, and one which is readily renewed.

Oath (A.-Sax. ath). An oath is defined by Paley 'the calling on God to witness, i.e. take notice of what we say; and invoking His vengeance, or renouncing His favour, if what we say be false, or if what we promise be not performed.' By the jurisprudence of nearly all known nations it has been admitted, in one form or another, as the solemn test of truth in judicial proceedings. Thus, as a general rule, all evidence in such proceedings must be given on oath by English law; and the having taken such oath subjects the witness to the penalties of perjury if his testimony be false. As to the exceptions to this rule, see EVIDENCE; WITNESS.

Oaths are still required by law on many occasions besides the giving evidence in judicial proceedings, and were formerly required still more frequently until the 5 & 6 Wm. IV. c. 62, which substituted solemn declarations in a great variety of cases, especially relating to the customs, excise, and post-office, and declared the making of such a declaration falsely to be a misdemeanour. Besides the Quakers and Moravians, several small sects of Christians profess conscientious objections to oaths, grounded on the express language of the Scriptures. The church of England, in common with the Catholic church in all ages, and with most varieties of Christians, considers judicial oaths lawful, and declares them so by her thirty-ninth article. They have been held mischievous or unnecessary by some philosophical writers, especially Bentham, in his *Rationale of Evidence*. The only answer to his arguments appears to be, that however unreasonable the belief that the duty of truth is rendered more imperative by the formality of an oath, still, while such a belief is prevalent, or while the imagination of witnesses in general is impressed by its solemnity, the convenience of retaining the practice overbalances the disadvantages.

Oatmeal. The grain of the Oat bruised or ground into a coarse meal. This meal, when stirred into boiling water with a little salt until it becomes of a pasty consistence, forms porridge, which, eaten with milk or treacle, forms a palatable food for persons who take good exercise. When made into dough with water, and baked into cakes on an iron plate, it forms bannocks or oat-cakes, the use of which was once almost universal in Scotland, the *land of cakes*. In Germany, coarse oatmeal, baked brown and then called *habermehl*, is used in broths and pottages, as the semolina made from wheat is used in France and Italy.

Obcordate (Lat. ob, *inversely*; cordatus, *heart-shaped*). In Botany, a term applied to bodies which are inversely heart-shaped, i.e. with the broad end forming the apex.

Obeah. A name applied to certain superstitious usages among the negro tribes of the western part of Africa, an Obea-man or Obea-woman being one who practises Obi. Our knowledge of these superstitions is derived not from African travellers, but from observation of negroes transplanted by the slave trade to the West Indies. The practitioners in the time of Bryan Edwards, who has described this sorcery in his *History of the West Indies*, were always persons born in Africa. They were consulted in cases of sickness or other emergency, and sold charms or spells. [FETICHISM.] A considerable knowledge of the art of poisoning was part of their accomplishments. A law was passed in Jamaica expressly for the suppression of this practice, which has been said, nevertheless, to subsist to some extent even in the present day. The system has assumed forms with which the history of witchcraft makes us familiar in almost all countries, one function of the Obea-women of the West Indies being to procure the death of a person whose waxen image is under their hands wasting away. But that the superstition is founded on the notion of a material connection between living beings or between living and inanimate things, seems to be proved by the singular custom of the Couvade (practised not only among negroes, but in America, and in the Basque country), which compels the husband to take to his bed when the wife bears a child, lest harm happening to him should extend to the infant also. (E. B. Tylor, 'Researches into the History of Mankind,' *Edin. Rev.* April 1864, p. 388.)

Obedience, Passive. In Politics, this term signifies the unqualified obedience which, according to some political philosophers, is due from subjects to the supreme power in the state. [NON-RESISTANCE.]

Obelisk (Gr. ὀβελίσκος). A lofty quadrangular monolithic column, diminishing upwards, with the sides gently inclined, but not so as to terminate in an apex at the top, the sides being sloped off so as to form a flattish pyramidal figure, by which the whole is suitably finished off and brought to a point, without the upper

part being so contracted as to appear insignificant. Egypt was, properly speaking, the land of obelisks; and they are probably to be reckoned among the most ancient monuments of that extraordinary people. It has been frequently asserted that obelisks were originally erected in honour of the sun, of which they were said to be symbolical, and that they served the purposes of a gnome or sundial; but the more common opinion is that obelisks were nothing more than monumental structures, serving as ornaments to the open squares in which they were generally built, or intended to celebrate some important event and to perpetuate its remembrance. They were usually adorned with hieroglyphics; and we learn from Diodorus and Strabo that the inscriptions with which they were charged declared the amount of gold and silver, the number of troops, and the quantity of ivory, perfumes, and corn which all the countries subject to Egypt were required to furnish. The two largest obelisks were erected by Sesostris in Heliopolis. They were formed of a single block of granite, and measured 180 feet in height. When Egypt became a Roman province, Augustus removed these obelisks to his own capital; and this practice found imitators both in some of his successors to the imperial throne, and, at a much later period, in many of the Roman pontiffs from the sixteenth century down to the present times. Of these obelisks, that of the Lateran, which is the largest now known, being 105 feet in height exclusive of the pedestal, and weighing 440 tons, was brought by Constantine from Heliopolis to Alexandria, and thence by Constantius, his son, to Rome, where it was erected in the Circus Maximus. The obelisk next in size to that of the Lateran was placed originally in the Vatican circus by Caligula, but it now stands in the piazza of St. Peter's; its entire height is 132 feet, including the pedestal, &c. The obelisks most generally known, at least in name, are the Luxor (removed to Paris in 1833) and the two monoliths called Cleopatra's Needles, of which one is standing and the other on the ground. Of these, the Luxor obelisk is 76 feet in height, while the Needle of Cleopatra which still stands is about 63 feet in height, exclusive of the pedestal, &c. (See the learned treatise of Zoega on Obelisks, and Sir G. Wilkinson's *Egyptians*, vol. iii. passim, which contains some excellent illustrations of the different methods adopted by that people for removing their huge structures from place to place.)

Obelisk. In Printing, a dagger, marked thus †, used as a reference to notes in the margin or at the bottom of the page.

Obelus. In Diplomatics, a mark so called from its resemblance to a needle (Gr. ὀβελός); usually thus — or thus ÷ in ancient MSS. It was used by Origen, in his *Hexapla*, to mark the passages where something is found in the Septuagint which is not in the Hebrew. The common use of the line — in modern writing is to mark the place of a break in the sense, where it is suspended, or where there is an ungrammatical transition; but a paragraph introduced where the sense is suspended is marked by the sign of a

Oberon. In Mediæval Mythology, the [illegible] of the fairies. Wieland's beautiful poem, [illegible] Weber's romantic opera of this name, the *Midsummer Night's Dream*, and innumerable other poems and tales of which he is the hero, have made the name of Oberon so familiar, that it will be unnecessary to do more in this place than to state the origin of the fable. The name Oberon first appears in the old French *fabliaux* of Huon of Bordeaux; it is identical with Auberon, or Alberon, the first syllable of which is nothing more than the old German word Alb, *elf* or *fairy*, which in the *Heldenbuch* and other old German poems is expressed variously by Alberich or Alban. (Grimm's *Deutsche Mythologie*, p. 256.) His wife's name was Titania, or Mab, whose powers have been so beautifully depicted in *Romeo and Juliet*.

Obesity (Lat. obesitas). This condition, to which the name of *polysarkia* (Gr. πολυσαρκία) has been given, is brought about by the deposit of an excessive amount of fat in the areolar tissue or subcutaneous network of cells. This excessive secretion of fatty matter is often the result of indolence, and excessive indulgence in farinaceous and saccharine foods and drinks. It would seem also that a tendency to obesity is hereditary in some cases; and in such cases it results in all probability from [illegible] peculiarity of the organism which is [illegible] with the [illegible] between the lung capacity an[d] the [illegible]rocesses. Many remarkable [illegible] are recorded of immense obesity; thus, a girl is spoken of in the *Philosophical Transactions* for 1813, who at four years of age weighed 256 lbs. Bright, of Maldon, and Daniel Lambert were both extraordinary instances of obesity, and weighed respectively 728 lbs. and 739 lbs. Much has been written on the best method of preventing and removing obesity; all, however, insist on the great principle of avoiding farinaceous, oily, and saccharine ingesta in every form; and when discretion is used, great advantage sometimes accrues from this plan to the patient. But, on the other hand, much evil may arise from the adoption of a disciplinary diet unwatched by a physiological observer; and this especially applies to the rapid reduction of obesity in those who are hereditarily predisposed to it.

Obi. [OBEAH.]

Obit (Lat. obitus, *death*). In the Roman Catholic ritual, a service performed for the repose of a departed soul.

Obituary. In the Roman Catholic Church, a register in which are enrolled the names of deceased persons for whom obits are to be performed, and the days of their funeral. It is also used for the book containing the foundation or institution of the several obits in a church or monastery. In the former sense it

is synonymous with *necrology*, in the latter with *martyrology*.

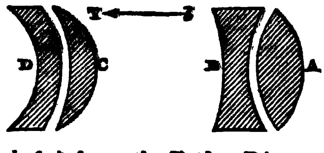
Object, Objective. In Philosophy, opposed to *subjective*. [SUBJECT, SUBJECTIVE.]

Object-glass of a Refracting Telescope or Microscope. The lens which first receives the rays of light coming directly from the object, and collects them into a focus, where they form an image which is viewed through the eye-glass.

The excellence of an object-glass depends on the distinctness of the image which it forms. On account of the unequal refrangibility of the rays of light, it is necessary, in order to procure a distinct image, to employ an achromatic combination of lenses, formed of substances having different dispersive powers, and of such figures that the chromatic and spherical aberrations of the one may be corrected by that of the other. The substances used are crown glass and flint glass; the dispersive powers of which are respectively as 3 to 5. By combining a convex lens of crown glass with a concave lens of flint glass, having their focal distances in that proportion, an image would be formed free from colour, but it would not be free from spherical aberration. The determination of the form of the compound lens which shall give the least possible spherical aberration for parallel rays is a problem which admits of exact calculation. The following are the dimensions found by Sir John Herschel for a telescopic object-glass of thirty inches focal length, of the form shown in the annexed figure, where A B is the convex lens of crown glass on the outside towards the object, and C D the concave lens of flint glass placed on the inside towards the eye: radius of the exterior surface *a* of the crown lens, 20·0364 inches; radius of the exterior surface *b* of the flint lens, 41·1687 inches; radii of the interior surfaces *c*, 10·1604 and 10·1613 inches. (*Ency. Metr.* art. 'Light,' § 471.) When the lenses have the forms here indicated, the focal lengths of each, separately, are in the direct ratio of their dispersive powers; and the two inside surfaces have so nearly the same curvature, that they may be ground on the same tool, and united by a cement to prevent the loss of light at the two surfaces. Such is one of the forms indicated by theory, but it is not the one now generally adopted; other forms are due to Fraunhofer, Gauss, &c.

It is well known, that for every lens, whether convex or concave, there is a form of minimum aberration for any given pencil of light; consequently, on either side, so to speak, of the minimum, there is a lens of one form having the same amount of aberration as a lens of another form on the other side of the minimum; that is to say, there are always two lenses of two different forms which have the same amount of spherical aberration for the same material, aperture, and focal length.

Suppose, then, a convex lens, A, of the Herschelian or Fraunhofer form is rendered aplanatic by a concave flint lens, B. Then A is double convex, having its exterior surface more curved than its posterior. Again, in Herschel's and



Fraunhofer's forms, the flint lens B is a concavo-convex lens, the anterior face being more curved than the posterior; there is, therefore, another lens, D, on the other side of the minimum aberration form, having for the same aperture and powers the same aberration as B, but convexo-concave, with its posterior or concave face much more deeply curved than the anterior.

These two lenses, C and D, produce the combination proposed by Gauss, and recently adopted by Steinheil. Their coexistence is rendered necessary by the existence of the other or Herschelian form. (Rev. C. Pritchard in *Monthly Notices R.A.S.* vol. xxv. p. 27.) The early telescopes, with a view of avoiding the *chromatic* aberration resulting from the employment of object-glasses of short focus, were constructed with focal lengths of enormous dimensions—300 feet in some cases. Till within the last few years, the difficulty of making glass of sufficient purity proved a great obstacle to the construction of object-glasses of large aperture. The difficulty was first obviated in Germany, and since that time in England, especially by Chance of Birmingham; and an object-glass of the astounding size of twenty-five inches aperture, the glass of which was made by him, is in process of mounting by Messrs. Cooke and Sons, of York.

The process of grinding a large object-glass, as conducted by that firm, is one of the greatest possible interest. Steam is the motive power employed by them, and, naturally, the years formerly required for the production of a lens of considerable size, say eight to ten inches, have been reduced to months. The density of the glass is first determined; and when this is known, the curves of the lenses are mathematically calculated. 'Tools' are then prepared of the various curvatures required, and after rough grinding the discs are applied to them, the tools being covered with a polishing surface supplied with dry emery. The perfection of the object-glass depends greatly upon the combination of motions given to the polisher. When the lenses are polished, the process of centring, by which the centres of all the curves are made to fall in the same straight line, is accomplished, and the object-glass is placed in a cell and tested for the two aberrations; the chromatic aberration being corrected by altering the curvature of that surface which least affects the spherical aberration.

The Northumberland object-glass at the Cambridge Observatory, by Cauchoix of Paris, is of eleven and a half inches effective aperture; but the largest in use at the present time are

those of the great telescopes belonging to the observatory of Chicago (of 18½ inches aperture), to the central observatory at Pulkova in Russia, and to the observatory at Cambridge in the United States, the extreme diameter being fifteen and a half inches, and the effective aperture about fifteen inches in both cases. The latter are the workmanship of Merz and Mahler, of Munich. [ACHROMATISM; LENS; TELESCOPE.]

For microscopic object-glasses the same processes are in the main adopted, but the combination is more complicated, and extreme difficulty is induced by the small size of the lenses themselves. In the $\frac{1}{50}$th object-glass recently completed by Messrs. Powell and Lealand, the object-glass is itself almost a microscopic object. [MICROSCOPE.]

Objective Case. In Grammar. The case commonly known as the ACCUSATIVE.

Oblate (Lat. oblatus, *offered*). In Ecclesiastical Antiquities: 1. A person who, on embracing the monastic state, had made a donation of all his goods to the community. 2. One dedicated to a religious order by his parents from an early period of his life. 3. A layman residing as an inmate in a regular community, to which he had assigned his property either in perpetuity or for the period of his residence. 4. A layman who had made donation, not only of his property, but his person, as bondsman to a monastic community. In France the king possessed, in ancient times, a privilege of recommending a certain number of *oblati*, chiefly invalided soldiers, to monasteries, whom they were bound to maintain.

Oblate Spheroid. [SPHEROID.]

Oblation (Lat. oblatio, *an offering*). This word means, properly, an offering presented to the church. This practice commenced at an early period in the history of the church, for originally the Christian priesthood had no other maintenance or allowance than the free gifts or oblations of the people. This is commonly thought to be the meaning of the word in the phrase *alms and oblations* in the Anglican Communion Service; though it is held by some to refer to the elements of the bread and wine.

Obligation (obligatio, from Lat. obligo, *I bind*). In the most general sense, a duty imposed by law, to the fulfilment of which one party is bound towards another. Obligations, according to the civil law, are said to arise in four ways; out of contracts, quasi-contracts, delicts, or quasi-delicts. A principal obligation is that by which a debtor is bound to his creditor; an accessory obligation, that by which one is bound to another to satisfy the contract of a third party. The Roman jurisconsults divided obligations into natural, civil, and mixed, and also into civil and prætorian. In English legal phraseology the word *obligation* is used as a technical term for a bond with penalty and condition. He who enters into an obligation is styled *obligor*; he towards whom it is entered into, *obligee*.

Obligato (Ital.). In Music, a term applied to a part in a composition for a particular instrument, which cannot be dispensed with.

Oblique (Lat. obliquus). Not perpendicular. Thus, in Geometry, an oblique section of a cylinder is one whose plane is not perpendicular to the axis. Again, a right line drawn from a given point to a given right line, and not perpendicular to the latter, is called an *oblique*. [DEPARTURE.]

Oblique Motion. In Contrapuntal Music, that motion in which one of the parts holds on a sound, whilst the other rises or falls.

Obliquity of the Ecliptic. In Astronomy, the inclination of the plane of the earth's equator to the plane of the ecliptic, or the angle formed by those two planes, on which the phenomena of the seasons depend. [ECLIPTIC.]

Oblong (Lat. oblongus). In Botany, a term applied to bodies which are elliptical and blunt at each end, as in the leaves of *Hypericum perforatum*.

OBLONG. In Geometry, a parallelogram which is equiangular but not equilateral. The term is synonymous with *rectangle*. A prolate spheroid is sometimes, though rarely, called an *oblong spheroid*.

Oboe (Ital.). A musical wind instrument, sounded through a reed. It is shaped somewhat like a clarionet, being slender in the upper part but spreading out conically at the bottom, and consists of three joints or pieces, besides the reed. Its compass is generally two octaves and a fifth, from C, below the treble clef, to G, the fourth line above the staff. The ancient name of oboe was *waught*, which is still visible in the modern word WAITS; and in this form the oboe was in use as far back as the reign of Edward III. It is only since the beginning of the present century that the Italian form of this word came into general use; previously to that period the French name, *hautbois*, was universally current.

Obolus (Gr. ὀβολός). An Athenian silver coin of very small dimensions; being only equal in value to about 1½*d*. of our money, or less according to some computations. Seven of them were equal to an Attic drachma.

Obovate (Lat. ob; ovatus, *egg-shaped*). In Botany, inversely ovate.

Obovoid. In Botany, a term applied to bodies which approach the obovate form.

Obrine. The name of a military order, instituted in the thirteenth century by Conrad, duke of Mazovia in Poland; styled also the Order of Jesus Christ. It was instituted to levy war against the Russians.

Obrok. A Russian word signifying *tax*. It is used in two senses, one for a rent, the other for the poll tax paid by peasants, who, being dependants on lords, have either been sent from the lords' domains to learn some manufacture, or have voluntarily quitted the locality of their birth or place of feudal dependence. This tax on the town peasants varied, according to Baron Haxthausen, from twenty to four hundred roubles of annual payment, i.e. from

3*l*. 2*s*. 6*d*. to 77*l*. sterling. It is possible that part of this payment is to be reckoned as an annual interest on the money expended for the education of the artisan. Of course the highest rates represent exactions levied on such of the peasantry as had succeeded in raising themselves into a position of affluence as traders. The Russian system of prædial servitude is comparatively modern, dating, we are told, from the seventeenth century, the period at which feudal institutions had become, to a great extent, extinct in the rest of Europe. Among the customs borrowed by the Russian aristocracy from those of feudal Europe, was that of an annual fine on non-resident serfs or villeins. But the Russian system was far more stringent than the ancient mode of assessing the license of non-residence, at least when compared with that which, under the name of *chivage*, prevailed in Western Europe. The chivage was fixed, and therefore commutable to a capitalised payment, the villein becoming free by such a transaction. But the obrok was arbitrary and variable, increasing with the value of the peasant's services, and therefore was a hindrance to emancipation. Thus, while the feudal condition of villeins was open to continual improvement, and was gradually, and almost insensibly, commuted for that of absolute freedom, the Russian serf residing in towns was never freed, and therefore the political counterpoise of the boroughs to the rural districts was unknown, and its future exceedingly remote. It is hardly needful to say, that the existence of the obrok was a serious hindrance to manufacturing and commercial industry, and that the emancipation of the body of artisans from the condition in which they were placed by the feudal institutions of Russia was essential to the growth and material progress of the country. This indeed is necessarily a work of time, since existing interests have to be regarded; but the long threatened reform was at last commenced in the years 1861 and 1863. In fine, the Russian system of villenage is a curious and instructive economical study, not only because it reproduces with great fidelity, though in sharper lines and with harsher features, the earliest characteristics of feudal polity, but because the state of transition on which it has now entered is full of great consequences in the future. The period during which the gradual emancipation is to take effect is forty-nine years. The social polity was by no means universal, never having prevailed in Siberia. For further information, the reader is referred to Haxthausen's *Russian Empire, its People, Institutions, and Resources*, and Tegeborski's *Les Forces Productives de la Russie*.

Obscurants. A philosophical nickname, applied, in Germany, to those who endeavoured in their writings to oppose the progress of modern enlightenment (Aufklärung), their doctrines being stigmatised under the term *obscurantism*.

Obsequies (Lat. obsequium, *complaisance*). Solemnities performed at the burials of eminent persons. The term is now used for the funeral itself.

Observants. A branch of the Franciscan order. [Recollets.]

Observatory. A place or building destined for the purpose of making astronomical or physical observations, and furnished with appropriate instruments.

According to Weidler, the first regular observatory in Europe was erected at Cassel, in 1561, by William, landgrave of Hesse. That of Tycho Brahe, in the island of Huen, was founded in 1576. From this time private observatories began to be multiplied; and some of them, as that of Hevelius at Dantzic, produced results which materially contributed to the progress of astronomy; but it was only in the following century that they came to be regarded, in the principal countries of Europe, as important and necessary public establishments. The royal observatory of Paris was built in 1667, that of Greenwich in 1675; the latter being professedly for the benefit of navigation. This original intention has never been lost sight of; and under a succession of eminent astronomers the Greenwich Observatory has done more towards determining the lunar motions, and the positions of fixed stars with which the moon's places may be compared by observations made at sea, than all the other observatories of Europe taken together. The instruments essentially necessary to an astronomical observatory are a transit instrument and sidereal clock, for the purpose of observing right ascensions; a circle, for observing polar or zenith distances; and a barometer and thermometer, for the purpose of ascertaining the state of the atmosphere, in order to determine the corrections to be applied for refraction. For the purpose, however, of observing the moon still nearer to her conjunctions with the sun, an altitude and azimuth instrument of admirable solidity and firmness was erected at Greenwich in 1847, and an excellent series of observations has already been made with it. Furnished with this apparatus, the astronomer is in a condition to obtain all the data requisite for the formation of catalogues and tables, and for establishing or perfecting the theories of the celestial motions and physical astronomy. Another instrument, though of secondary importance in such observatories as are now in question, is also wanted for the observation of phenomena out of the meridian, as eclipses, occultations, comets, &c. The most convenient instrument for this purpose is the Equatorial [see the term]; and if the astronomer carries his views to the exploring of the sidereal spaces, to observe the forms of nebulæ, and watch the changes and motions of double and multiple stars, the equatorial must be a telescope of the largest size; or a powerful reflecting telescope, suspended so as to have a free motion in azimuth, may be employed instead of it. In this department of astronomy all depends on the goodness of the telescope; the objects to be examined being, in fact, only

limited by the power of seeing them. But as these researches have no immediate practical application, they are not considered as included among the purposes for which public observatories are established, and are therefore left to the zeal of individuals. A fine refractor equatorially mounted has, however, recently been erected in the Greenwich observatory.

Public observatories are now established and maintained by the governments of almost every civilised country, and means are provided of publishing the observations, and rendering their results immediately available to the progress of astronomical science. The number of private observatories, particularly in this country, is very considerable; and several of them, in the sumptuousness of their instruments, vie with, and even excel, the first and best appointed public institutions. Amongst these may be mentioned the observatories of Lord Rosse, Mr. Warren de la Rue, Mr. Gurney Barclay, Mr. Bishop, Rev. W. R. Dawes, Lord Wrottesley, Dr. Lee, Mr. Fletcher, Mr. Knott, Mr. Baxendell, and Mr. Nasmyth. From Mr. Warren de la Rue's observatory a splendid series of photographs of the moon and planets has recently been issued. The labours of Mr. de la Rue in celestial photography form a new and important era in astronomical science. Nor must we forget to mention that Mr. Lassell, another private observer, has for several years, at Malta, made diligent use of a reflector, with a speculum of four feet in diameter, of his own construction.

The following is a list of the principal public observatories, with their latitudes and longitudes (in time) from that of Greenwich, as given in the *Nautical Almanac*:—

	Latitude				Longitude			
	°	′	″		h.	m.	sec	
Abo (Finland)	60	26	57	N	1	29	8·8	E
Altona	53	32	45	N	0	39	46·6	E
Armagh	54	21	12·7	N	0	26	35·5	W
Berlin	52	31	13·5	N	0	53	35·5	E
Bremen	53	4	36	N	0	35	15·9	E
Cambridge	52	12	51·8	N	0	0	23·5	E
Cape of Good Hope	33	56	3	S	1	13	55	E
Copenhagen	55	40	53	N	0	50	19·8	E
Dorpat (Russia)	58	22	47	N	1	46	55	E
Dublin	53	23	13	N	0	25	22	W
Edinburgh	55	57	23·2	N	0	12	43·6	W
Geneva	46	11	59·4	N	0	24	37·5	E
Göttingen	51	31	48	N	0	39	46·5	E
Greenwich	51	28	39	N	0	0	0	
Königsberg (Prussia)	54	42	50	N	1	22	0·6	E
Madras	13	4	9·2	N	5	21	3·8	E
Marseilles	43	17	50·1	N	0	21	29	E
Munich	48	8	45	N	0	46	26·5	E
Oxford	51	45	40	N	0	5	1·5	W
Palermo	38	6	44	N	0	53	25·6	E
Paramatta (New South Wales)	33	48	49·8	S	10	4	6·25	E
Paris	48	50	13	N	0	9	21·5	E
Petersburg	59	56	31	N	2	1	15·8	E
Rome	41	53	52	N	0	49	54·7	E
St. Fernando (near Cadiz)	36	27	45	N	0	24	19·1	W
Turin	45	4	6	N	0	30	48·4	E
Vienna	48	12	35	N	1	5	31·9	E

Obsession (Lat. obsessio, from obsideo, *I besiege*). The state of a person who is said to be vexed or besieged by an evil spirit. In the language of exorcists, demoniacal obsession differed from demoniacal possession: in the latter, the demon had possession of the patient internally, in the former, he attacks him from without. Thus, the state of Sara, the bride of Tobias, whose bridegrooms were killed by an evil spirit haunting her (Tob. iii. 8), was one of obsession. The marks of obsession were said to be: the being miraculously hoisted or elevated in the air, speaking languages of which the patient had no knowledge, aversion to the offices of religion, and so forth. [POSSESSION, DEMONIAC; EXORCISM.]

Obsidian (Gr. ὀψιανός). A volcanic glass, produced by the fusion of felspathic rocks, or those containing or composed of alkaline silicates. The composition is, in consequence, very variable, and depends upon that of the rock which has been melted down. It is of various colours, but generally black and opaque in mass, but ash-grey and translucent on thin edges. It is remarkable for its perfect conchoidal fracture and for its sharp cutting edges, advantage of which is occasionally taken in Mexico and Peru to fashion it into cutting instruments, as well as into the points of arrows and lances. Obsidian is chiefly found in Iceland, Ascension, Teneriffe, the Lipari Islands, Mexico, Peru, and New Zealand.

Obsidional Coins. In Numismatics, pieces struck in besieged places to supply the want of current money. They are of various base metals, and of different shapes. Some of the oldest known are those which were struck at the siege of Pavia, under Francis I.

Obsidional Crown (Lat. corona obsidionalis). In Roman Antiquities, a crown granted by the state to the general who raised the siege of a beleaguered place. It was formed of grass growing on the rampart.

Obsolete (Lat. obsoletus). In Zoology, this term implies that a part, or a spot, or other character, is scarcely discoverable.

Obstetrics (Lat. obstetricium, sc. officium, from obstare, *to stand so as to give assistance*). The name frequently given to the science of midwifery.

Obtemper (Lat. obtempero, *I obey*). In Scotch Law, to obey or comply with a judgment of a court.

Obtundents (Lat. obtundo, *blunt*). Mucilaginous, oily, and other bland medicines, supposed to sheathe parts from acrimony, and to blunt that of certain morbid secretions.

Obturator Muscles (Lat. obturare, *to close up*). Certain muscles which fill up openings in bones.

Obtuse Angle (Lat. obtusus, *blunted*). In Euclidian Geometry, an angle greater than a right angle, but less than two right angles. *Obtuse*, in this sense, is opposed to *acute*.

Obverse or **Face.** In Numismatics, the side of the coin which contains the principal symbol: usually, in the coins of monarchical states, ancient and modern, the face in profile

of the sovereign: in some instances, the full or half-length figure. [NUMISMATICS.]

Oca. The Peruvian name for the tuber-bearing species of *Oxalis*, viz. *O. crenata* and *O. tuberosa*.

Occasionalism or **The System of Occasional Causes.** In Metaphysics, a name which has been given to certain theories of the Cartesian school of philosophers (especially Arnold Geulinx, of Antwerp), by which they accounted for the apparent action of the soul on the body; e.g. in the phenomena of voluntary motion. According to these theories (which were more or less clearly developed by different writers), the will was not the *cause* of the action of the body; but whenever the will required a motion, God caused the body to move in the required direction. [HARMONY, PRE-ESTABLISHED.]

Occidental (Lat. occidentalis, *belonging to the setting sun*). In Gem Sculpture, a term applied to those precious stones which possess an inferior degree of hardness and beauty.

Occipital Bone (Lat. occiput, *the back part of the head*). The irregularly shaped bone which forms the posterior and inferior part of the skull.

Occult Sciences (Lat. occultus, *hid*). A term applied to the imaginary sciences of the middle ages—magic, alchemy, astrology, especially the former.

Occultations (Lat. occultatio, from occulto, *I conceal*). Sometimes called *lunar occultations*, or *occultations of stars by the moon*. Those phenomena in which a star or planet becomes hidden from our view by the intervening passage of the moon. By analogy, a total eclipse of the sun might be called an occultation of the sun by the moon.

As the motion of the moon in her orbit is from west to east, it is obvious that, when she is about to pass over a star, the first contact, or the immersion, must occur on her eastern limb; and the emersion, or reappearance of the star, must take place on her western limb. It should, however, be observed, that some slight exceptions to this rule may be found where the moon has considerable motion in declination, and where the star is only grazed over by a small portion of the northern or southern limb. In these few exceptional cases, the disappearance and reappearance of the star may both occur either on the eastern or the western side of the limb.

An occultation, like a solar eclipse, is presented only to a portion of the terrestrial globe. For suppose an observer to be stationed at the star, with the moon between him and the earth, and that he could perceive the moon's disc projected on that of the earth; then he would observe that the moon, in her passage over the earth, only covered a portion of the terrestrial disc, and it is evident that the phenomenon of the occultation of the star could only be presented to that portion of our globe.

The principles which enter into the calculation of occultations are just the same as for eclipses of the sun; the only difference consists in the star having neither motion, parallax, nor semidiameter, so that the moon's motion and parallax are to be employed in place of the relative motion and the relative parallax. For the mode of conducting the calculation, it will therefore be sufficient to refer to the article ECLIPSES, and to observe that the consideration may perhaps be simplified by giving to the star a motion contrary and equal to that of the moon, and then supposing the moon herself to be stationary.

In the case of a planet, it may be necessary to take into account its motion and parallax, and perhaps its semidiameter, if great nicety is required.

For minute details, in reference to the calculation of occultations in all their varieties, the reader may consult Jeans' *Navigation*, part ii. The Astronomer Royal has lately inferred, from the occultations at the dark limb, that the moon's apparent telescopic character is much increased by irradiation. [MOON.]

Occupancy (Lat. occupo, *I seize*). In Law, the taking possession by any one of a thing of which there is no owner, and the right acquired by such taking possession. Anciently, when a man held land pur auter vie (for the life of another), and died before that other, as this estate could not descend to his heir, nor revert to the donor until the determination of the life upon it, it was considered to belong of right to the first who took possession of it for the remainder of the life, which was termed *general occupancy*. When the gift was to one *and his heirs* for the life of another, the heir was said to take as *special occupant*. The Statute of Frauds (29 Ch. II. c. 3 sec. 12) extended the testamentary power to lands held pur auter vie; and it is now provided by the Wills Act (7 Wm. IV. & 1 Vict. c. 26) that a testator may devise lands held by him pur auter vie; and if no such devise be made, and there be no special occupant, the estate goes to his executors or administrators, and is assets in their hands.

Occupation Bridge. A bridge erected for the convenience of access of the landowners of property severed by a canal, a railway, or a common road. Occupation bridges may be either foot, or bridle, or cart bridges; and the latter are usually made so that the inclination of the line of their axis shall not exceed more than one in sixteen, though in mountainous districts the inclination given to occupation bridges may be as much as one in eight.

Ocean (Gr. Ὠκεανός). The name given to the great body of water covering to considerable but variable depth a large proportion of the earth's surface. For the sake of convenience, various names are given to certain portions of the great ocean, and also to the smaller tracts of oceanic water penetrating the land or nearly enclosed by it.

The principal divisions or oceans are the ATLANTIC, the PACIFIC, the INDIAN, the ARCTIC,

and the ANTARCTIC. The principal smaller bodies of salt water having special names are either SEAS, as the MEDITERRANEAN; GULFS, as the MEXICAN GULF; or BAYS, as HUDSON'S BAY. All these will be found referred to under special headings.

The total area of ocean is generally estimated at about 145 millions of square miles, being two-thirds of the whole surface of the globe. The most remarkable physical phenomena are the depth of water, the quantity of salt and other solid matter contained in the sea, the colour, and occasional phosphorescence of the sea, the temperature, the various TIDES and CURRENTS that disturb its equilibrium, and the nature of the COAST-LINE enclosing the various subdivisions. The former of these will be briefly considered in the present article, the rest being noticed under distinct headings. The general outlines of the subject, and its reference to the other phenomena of water on the earth, are treated under the title HYDROLOGY.

Depth of the Ocean.—Up to a very recent period, the only means of ascertaining by experiment the depth of deep or 'blue' water, and the nature of the sea bottom at great depths, were extremely insufficient and unsatisfactory. The apparatus now generally employed consists of a very heavy weight carrying down a pair of nippers or clamp, serving as a kind of dredge. When the weight reaches the bottom, it detaches itself and is left behind, the line bringing up the dredge or clip with considerable quantities of the bottom when it is soft or movable. The observations made with these modern contrivances have been chiefly in the North Atlantic Ocean, and in reference to the determination of a line fit for the reception of a telegraph cable, but the results are very important in general hydrology.

The bed of the North Atlantic is shallow for some distance from the land on both shores, and as far as 230 miles from the Irish coast is only 1,320 feet deep. Within twenty miles there is then a fall of 9,000 feet, and from this to the corresponding point on the American side, a distance of 1,200 miles, the depth continues almost the same, the bottom very slightly undulating.

From various observations made at different times, it appears that the bottom of the North Atlantic descends in a series of step-like depressions to a depth of about 30,000 feet below the mean level of the surface. Between the North and South Atlantic is a submarine mountain chain broken by deep gorges, and coming to the surface in the Azores and Cape de Verd islands. The South Atlantic is deep, but unknown. The Pacific appears to be deeper than the Atlantic in proportion to its greater extent, but the soundings are less complete.

Mineral Contents of Sea-water.—The proportion of common salt held in the sea varies considerably in different parts of the ocean and at different depths. The average of solid matter is about thirty-four and one-third parts in a thousand, of which about two-thirds is common salt. Of the remainder, the principal constituents are chloride of magnesium (about five and a half parts in a thousand) and sulphate of soda (about four and a half parts in a thousand), the rest being chiefly carbonate of lime and silica. Traces more or less abundant of thirty-one of the elements have been already found in sea-water, and probably others exist. The list includes all the gases, all the non-metallic solids except selenium; and of the metals, gold, silver, copper, lead, zinc, cobalt, nickel, arsenic, iron, manganese, aluminium, magnesium, calcium, strontian, barium, sodium, potassium, lithium, and the newly determined elements cæsium and rubidium.

The saltness of sea-water at particular places is influenced by temporary causes—storms, for example; as well as by the neighbourhood of large rivers, and permanent accumulations of ice. A series of experiments on this subject were made some years ago, and the following are the general conclusions deduced: 1. the Southern Ocean contains more salt than the Northern Ocean, in the ratio of 1·02919 to 1·02757. 2. The mean specific gravity of sea-water near the equator is 1·02777. 3. There is no evidence that the sea at great depths is more salt than at the surface. 4. The sea in general contains more salt where it is deepest; and its saltness is always diminished in the vicinity of large masses of ice. 5. That small inland seas, communicating with the ocean, are generally less salt than the ocean. 6. The Mediterranean contains a rather larger proportion of salt than the ocean.

Colour and Phosphorescence.—The usual colour of the ocean is a bluish-green, of a darker tint at a distance from land, and clearer towards the shores. According to Mr. Scoresby, the hue of the Greenland sea varies from ultramarine blue to olive green, and from the purest transparency to great opacity. The surface of the Mediterranean, in its upper part, has at times a purple tint. In the gulf of Guinea the sea sometimes appears white; about the Maldive Islands black; and near California it has a reddish appearance. Various causes co-operate to produce this diversity of tint. The prevailing blue colour may be ascribed to the greater refrangibility of the blue rays of light, which, by reason of that property, pass in greatest abundance through the water. The other colours are ascribed to the existence of vast numbers of minute animalculæ; to marine vegetables at or near the surface; to the colour of the soil, and the infusion of earthy substances; and very frequently the tint is modified by the aspect of the sky. The phosphorescent or shining appearance of the ocean, which is a common phenomenon, is ascribed to animalculæ, and especially to the *Noctilucæ*.

Temperature of the Ocean.—Water being a slow conductor of heat, the temperature of the ocean is much more uniform than that of the atmosphere. At a certain distance from the equator, it follows, though not very closely,

the mean temperature of the corresponding latitudes; the solar action being greatly modified by the existence of currents which convey the temperature of one region to another; so that at any place the temperature of the water depends in some measure on the direction of the currents. Within the tropics the mean temperature at the surface is about 80° Fahrenheit, and generally ranges between 77° and 84°. At great depths the temperature is nearly the same under every latitude. In the torrid zone it is found to diminish with the depth; in the polar seas it has been supposed to increase with the depth, but recent observations seem to render this doubtful. About the latitude of 70° it is nearly constant at all depths.

Oceanus (Gr. Ὠκεανός). In Mythology, according to the Hesiodic *Theogony*, the son of Ouranos and Gaia. His consort was Tethys, his daughters being the Oceanides. In Homer, the word *ocean* denotes the *river* or stream into which the sea—*θάλασσα*—opened, and which was supposed to encompass the earth.

Ocelot (Mex. ocelotl). Several small species of *Felis*, found in South America, are thus named. They are distinguished by spots of a black or dark colour on a tawny ground, disposed in an irregular striped pattern, parallel with the central line of the back. They are found in Brazil, where they are often confounded with the larger spotted *Felidæ* termed jaguars.

Ochlocracy (Gr. ὀχλοκρατία, *mob-rule*). A word coined to express the condition of a state in which the populace has acquired an immediate illegal control over the government; and, by a figure commonly used in the exaggeration of political speakers and writers, a government in which the power of the lower classes predominates, either for a time or permanently.

Ochnaceæ (Ochna, one of the genera). A natural order of hypogynous Exogens belonging to the Rutal alliance. Its distinguishing features in that group are its succulent conical torus, and its one-seeded apocarpous fruit, whose pericarp does not laminate. The species, which are comparatively few, possess some medicinal properties, the prevailing quality being bitterness. They are found in tropical India, as well as in America and Africa.

Ochran. A yellow variety of Bole, from Orawitza, in the Bannat.

Ochre (Gr. ὠχρός, *pale*). A name applied to certain metallic oxides occurring in an earthy or pulverulent form, especially to such as are used for pigments, as red ochre, yellow ochre, &c.

Ochreous Iron-ore. A name given to ochreous and pulverulent forms of Hæmatite and Limonite.

Ochro or **Ochra.** The *Abelmoschus esculentus*; Musk Ochro is *A. moschatus*.

Ochroite. The name given by Hermann to a mineral which is, probably, a variety of Cerite, rendered impure by an admixture of Quartz.

Ochroma (Gr. ὠχρός, *pale yellow*). A genus of *Sterculiaceæ* belonging to South America, the most remarkable species of which is *O. Lagopus*, a tree forty feet high, common in the West Indies and Central America, yielding a soft spongy and exceedingly light wood, called *corkwood*, commonly employed as a substitute for cork, both for stopping bottles, and for the floats of fishing nets.

Ocimum (Gr. ὤκιμον). The genus of *Labiatæ* to which belongs the Basil, one of the most fragrant and aromatic of kitchen herbs. The most esteemed kind is *O. Basilicum*, the flavour of which somewhat resembles cloves, and is much employed in cookery as a seasoning.

Ocrea, less properly **Ochrea** (Lat. *a boot*). In Botany, a name applied to stipules that are membranous, and surround the stem like a sheath, cohering by their anterior margins, as in *Polygonum*.

Ocreæ (Lat.). In Roman Antiquities, a covering for the legs, made of bronze, brass, tin, and sometimes of silver and gold, and lined probably with felt or leather. They were equivalent to the *κνημῖδες* of the Greeks, and the greaves of the English. [Greaves.]

Octaeteris (Gr. from ὀκτώ, *eight*, and ἔτος, *a year*). A cycle or period of eight years, after the lapse of which three lunar months were added. This cycle was in use till Meton's invention of the golden number, or cycle of nineteen years. (Sir G. C. Lewis, *Astronomy of the Ancients*, p. 38.)

Octagon (Gr. ὀκτώ, and γωνία, *angle*). In Geometry, a plane rectilineal figure, having eight angles. A *regular octagon* is equiangular as well as equilateral; its area is 4·8284271 times that of the square on one of its sides.

Octahedrite. A name for Anatase (oxide of titanium), from its occurrence in octahedrons.

Octahedron (Gr. ὀκτώ, and ἕδρα, *side*). In Geometry, a solid bounded by eight planes or faces. The *regular* octahedron, one of the five Platonic bodies, is bounded by eight equal equilateral triangles. It has six corners or solid angles, each of which is formed by the meeting of four equal plane angles, and twelve edges. Its volume is 0·4714045 times that of the cube on one of its edges.

Octandria (Gr. ὀκτώ, and ἀνήρ, *a male*). In Botany, one of the Linnæan classes, distinguished by having eight stamens.

Octans. In Astronomy, *Octans Hadleianus* (Hadley's Octant), one of the constellations formed by Lacaille in the southern hemisphere. [Constellation.]

Octant. In Astronomy, *octant* denotes a position or aspect; thus the moon is in her octants when she is in the positions intermediate between her syzygies and quarters, or at 45°, 135°, 225°, and 315° from her conjunction.

Octant. In Geometry, the eighth part of a circle.

Octastyle (Gr. ὀκτάστυλος). In Architecture, a temple or other building having eight columns in front.

Octave (Lat. octavus). In Ecclesiastical usage, the eighth day after a feast, the feast day itself included. Thus, the first Sunday

after Easter is the octave of Easter; and the Circumcision (Jan. 1) is the *octava natalis Domini*, the octave of Christmas.

OCTAVE. In Music, an harmonical interval, containing five tones and two semitones, called by the ancient authors *diapason*.

Octavo. Usually contracted 8vo.; that which by a peculiar folding has eight leaves to a sheet.

Octinvariant. [INVARIANT.]

October (Lat.). The eighth month of the old Roman year, which began with March. It is now the tenth month. [CALENDAR.]

Octopods (Gr. ὀκτώ, *eight*; πούς, *a foot*). The name of a tribe of dibranchiate Cephalopods, including those which have only eight feet or cephalic tentacular appendages; also of a sub-order of apterous insects, including those which have eight feet, as the tracheary Arachnidans.

Octroi (Fr.; from Lat. auctoritas, *authority*). Privilege or prerogative. This word implied originally a right, such as a franchise, a charter, or a monopoly, granted to some individual by the monarch. In modern times it has been used almost exclusively to represent the taxes levied by the corporations of towns in France, on all articles of consumption introduced within the barriers. These taxes form great part of the revenue of the principal towns, and are faintly represented among ourselves by the coal-tax levied for the benefit of the city of London.

It does not by any means follow that an octroi is necessarily a mischievous form of taxation; though it may not be, and seldom is, wholly just in its incidence. It does not appear to be wasteful; for, being levied on articles of immediate consumption, it cannot increase the price of the commodity taxed by much more than the amount of the impost, and in so far as it is expended on police, or for other purposes immediately beneficial to the inhabitants, it may be fairly levied on all alike. But if, as is commonly the case, a great part of the proceeds is laid out in the permanent improvement of the city or town, it is a tax on consumers expended for the benefit of landlords, and its incidence is unjust. On the whole, it does not contrast unfavourably with our own system of local taxation, which is for the most part levied on the occupier or consumer, and seldom upon property, even when the benefit of the tax is almost exclusively reaped by property in the shape of permanent improvement. Such taxes as rates for making bridges, roads, drains, workhouses, in so far as they do not imply repairs, and the restoration of a portion of the loss caused by wear, are entirely for the benefit of property, and should be paid exclusively by landlords. [TAXATION.]

Octyl. *Capryl.* A hydrocarbon represented by C_8H_{17}.

Octylene. An oily body represented by C_8H_{16}.

Ocythoe (Gr. ὠκύθοος, *swift-running*). The name applied by Rafinesque to a naked Cephalopod, supposed to be that which inhabits and constructs the argonaut shell.

Odalisques, properly **Odaliks** (Turk. oda, *a chamber*). Female slaves employed in domestic service about the persons of the wives, female relatives, &c. of the sultan.

Odd Number. In Arithmetic, any number not divisible by 2 without remainder; the series of odd numbers is 1, 3, 5, 7, 9, &c.; and the algebraic form by which they are expressed is $2n+1$. Every prime number, excepting 2, is an odd number. The differences of the successive terms of the series of square numbers produce the odd numbers.

Ode (Gr. ᾠδή, *a song*). Among the Greeks and Romans, a short lyric composition, usually intended to be sung, and accompanied by some musical instrument, generally the lyre; hence the expression *lyric verse*. In the modern sense of the word, the ode appears to be distinguished from the song by greater length and variety, and by not being necessarily adapted to music. It is distinguished also from the ballad and other species of lyric poetry, by its being confined to the expression of sentiment, or of imaginative thought, on subjects not admitting of narrative except incidentally. The odes of Pindar, Anacreon, and Horace, are, in fact, the models on which the modern notion of the ode is formed. Until the science of Greek metres was accurately explored, the Pindaric ode was supposed to admit of an excessive irregularity in the length and measure of lines; and hence the Pindaric odes of the last and preceding century are constructed on a system of absolute license in this respect. In point of fact, however, a scheme of perfect metrical regularity pervaded the Greek ode both in Pindar and in the dramatic choruses, in which a strophe, or succession of lines in varied metres, is exactly answered in the antistrophe or corresponding series. On the other hand, the Anacreontic ode consists of a number of lines of the same metrical length and arrangement. The Horatian ode, again, is generally constructed on a different system, of which we have only a few instances in Greek, in the *Fragments* of Alcæus and Sappho: it consists of an indefinite number of stanzas, precisely similar to each other, each forming a complete metrical whole. [DITHYRAMBIC ODE; METRE.]

Oderite. A variety of black Mica from Sweden.

Odeum (Gr. ᾠδεῖον). In Greek Architecture, a building in general form and arrangement closely resembling the theatre, but much smaller, and designed for musical rehearsals in preparation for the celebration of the great festivals. The first building of this kind at Athens was raised by Pericles, the roof being constructed, it is said, of masts and yards taken from Persian ships at the time of the invasion of Xerxes. Others were erected in later times, the most magnificent being that of Herodes Atticus. But no detailed description of this class of buildings is extant.

Odials. The young roots of the Palmyra Palm, *Borassus flabelliformis*, which are eaten in Ceylon.

Odin. A Scandinavian deity, who seems, like the Zeus of the Greeks, to have formed the connecting link between the ancient and more recent systems of their mythology. Odin is the chief of the gods; by his wife Freya or Friga, he has two chief sons, Thor and Baldr; the death of the latter (for the Scandinavian gods are not all immortal) furnishes many legends to the northern mythology, parallel to those of Achilles, Rustem, Meleager, and other heroes.

According to the Norse mythology, Odin and the Æsir were to reign until the twilight of the gods had come, a notion embodied also in the Æschylean legend of Prometheus. [WODEN.]

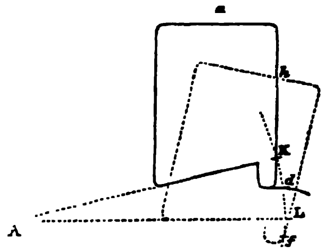
Odmyl. A product resulting from the distillation of oleic acid with sulphur.

Odometer, more properly **Hodometer** (Gr. ὁδόμετρον, from ὁδός, *a way*, and μέτρον, *a measure*). An instrument by which the distance traversed by a man or a machine is ascertained, and in which a wheel registers the number of times that a movement of oscillation is impressed upon it. Evidently the correctness of the distance ascertained in this manner must depend upon the correctness with which the unity of the motion is ascertained in the first instance, and the correctness with which the divisions are maintained and registered.

Odontalgia (Gr. ὀδονταλγία). The toothache.

Odontograph. In Mechanics, an instrument invented by Professor Willis for finding the arcs of circles, which, used in the construction of the teeth of wheels, will work truly on each other. It consists of a graduated card or piece of wood, by which the position of the centres and radii of the arcs of the teeth can easily be found. This instrument is of the form shown in the cut *a*, but of course on a small scale. It has the bottom edge bevelled off at an angle of 75°. The point where this would cut the right-hand edge is the zero of the scales. These scales are graduated to twentieths of an inch, to avoid fractional parts in the tables, and depart in each direction from the zero, the upper being that employed in finding the centres of the flanks of the teeth or parts within the pitch circle, and the lower for finding the centres of the faces of the teeth or parts without the pitch circle. Tables are given on the odontograph for finding the graduation on the scale corresponding to any given pitch and number of teeth. For intermediate pitches, not given in the table, or for wheels of greater size, the corresponding numbers can be found by simple proportion. For wheels of only twelve teeth the flanks are straight, and form parts of radii of the pitch circle.

Let A be the centre of a wheel, K *d* L the pitch line. Set off K L equal to the pitch, and bisect it in *d*. Draw radii A K, A L. Place the odontograph with its bevelled edge on the radius A K, and zero of the scale on the pitch line. Then look out, in the table of centres for the flanks of teeth, the number corresponding to the pitch, and required number of teeth, and mark off this point *h* from the scale of centres for the flanks of teeth. Then remove the odontograph, and similarly place it on the radius A L. Find in the table of centres for the faces of the teeth the number corresponding to the pitch and number of teeth in the wheel, and mark it off at *f*, on the scale for centres of the faces of teeth. Then describe two arcs from *h* and *f*, with *h d* and *f d* as radii; these



will form the side of a tooth. Then, from *d* let the pitch line be marked off into as many equal spaces as there are teeth in the wheel, and let these be divided proportionally to the widths of the teeth and spaces. Through *h* and *f*, with radii A *h* and A *f*, draw circles. Take *h d* as a radius, and, placing one foot of the compass on the divisions of the pitch line, and the other in the circle drawn through *h*, describe a series of arcs forming the flanks of the teeth. Similarly with radius *f d*, and one leg of the compass on the circle drawn through *f*, describe the faces of the teeth.

For an annular wheel the same rules apply, only that the part of the curve which is face in a spur wheel becomes the flank in an annular wheel, and vice versâ. For a rack, the pitch line is straight, and A K, A L are parallel and perpendicular to it, at a distance equal to the pitch.

As these odontographs may be purchased in a very convenient form, with tables for their use, and also with tables of the widths of teeth, and spaces and length of teeth within and without the pitch circle, it is not necessary to describe them in further detail here. (Fairbairn's *Mills and Millwork*.)

Odontolite (Gr. ὀδούς, *a tooth*, and λίθος, *stone*) or **Bone Turquoise.** The name given to fossil bones or teeth, coloured by oxide of copper, which are found in certain tertiary deposits, as in Bas Languedoc.

Odontology (Gr. ὀδούς, and λόγος). The branch of anatomical science which treats of the teeth. [DENTES.]

Odorin. One of the products of the redistillation of the volatile oil obtained by distilling bone; it has a very strong and diffusible empyreumatic odour, and is regarded by Unverdorben as a peculiar salifiable base.

Odours of Flowers. The odours of flowers are turned to good account by the

perfumer, whose choicest scents are in great measure derived from this source. Mr. Rimmel gives the following classification of them:—

Classes	Types	Odours belonging to the same Class
Rose . . .	Rose . . .	Geranium. Sweetbriar. Rhodium or Rosewood.
Jasmine . .	Jasmine . .	Lily of the Valley.
Orange-flower	Orange-flower	Acacia. Syringa. Orange leaves.
Tuberose . .	Tuberose .	Lily. Jonquil. Narcissus. Hyacinth.
Violet . . .	Violet . .	Cassia. Orrisroot Mignonette.
Balsamic . .	Vanilla . .	Balsam of Peru. Balsam of Tolu. Benzoin. Tonquin bean. Heliotrope.
Spice . . .	Cinnamon .	Cassia. Nutmeg. Mace Pimenta
Clove . . .	Clove . .	Carnation. Clove Pink.
Camphor . .	Camphor .	Rosemary Patchouly
Sandal . . .	Sandalwood	Vetivert. Cedar Wood.
Citrine . .	Lemon . .	Bergamot. Orange Cedral. Limetta.
Lavender . .	Lavender .	Spike Lavender. Thyme Serpolet Marjorum.
Mint. . .	Peppermint	Spearmint. Balm. Rue. Sage.
Aniseed . .	Aniseed . .	Badiane. Caraway Dill. Coriander. Fennel.
Almond .	Bitter Almonds .	Laurel. Peach kernels.
Musk . . .	Musk . .	Musk-seed. Musk-plant.
Amber . . .	Ambergris . .	Oak-moss.
Fruit . . .	Pear . . .	Apple. Pine apple. Quince.

Odysseus (Gr. 'Οδυσσεύς). The mythical chieftain of Ithaca, whose exploits in the war against Ilion are recounted in the *Iliad*, and whose return from Troy is related in the *Odyssey*. In the former, the interest attaching to this hero is subordinated to that of Achilleus (Achilles); but from the moment of leaving the Trojan shore, he comes before us as a being possessed by one absorbing desire—the longing to see his home and his wife once more. This groundwork of the poem at once suggests a comparison with the leading ideas in such myths as those of Heracles and Iolê, Perseus and Danaê, Paris and Œnônê, Sigurdr and Brenhyldr; and the solar character thus suggested is supported by the general current of the narrative as well as by minor details of incidents and peculiarities of expression. Like Achilleus, Odysseus is attended by Athênê, the dawn-goddess [MINERVA], and like him he has a weapon which none but himself can wield. His journey from Troy to Ithaca exhibits alternations of gloom and sunshine, but the gloom is greatest as he approaches his own shores. Athênê here, it is said, destroys his golden locks, and takes away all beauty from his countenance. He enters his house in the tattered garments of a beggar; but when surrounded by the suitors whom he is about to slay [PENELOPÊ], the ancient splendour returns, as his arrows, which, like those of Phœbus and Artemis, never miss their mark, bathe the hall in blood. Like Achilleus in his vengeance, Odysseus is not satisfied until all his foes are slain, and until he has wreaked his fury on the body of Melanthius, as Achilleus insulted that of Hector. The incidents in the closing scenes are in close parallel with those of the final conflict in the *Iliad*, and even the temporary dismay of Achilleus when struggling with the streams of Scamander and Simoeis, reappears in the fear of Odysseus when for a brief moment the suitors seem likely to get the upper hand. The poem closes with a splendid picture of repose, and Odysseus finds Penelopê in her bridal chamber not less fair than when he had left her to go to Troy, as Iolê and Œnônê appear in all their radiant beauty in the last hours of Heracles and Paris.

The character of Odysseus is, in short, precisely the same ethically as that of Achilleus, Meleagros, Paris, Bellerophon, and other heroes, and regarded in its groundwork, far from being taken as the true portrait of an Achaian chieftain, it is in strictness of speech scarcely human. The attempt to treat these portraits as genuine pictures of national character may go far to justify the repulsion which Mr. Dasent and other recent writers openly avow for all Greek mythology. This view of the character of Odysseus may be found in Colonel Mure's *History of Greek Literature*: for the degree in which it fails to explain the incidents and the language of the *Odyssey*, see Cox, *Thebes and Argos*, p. 93 &c.

The name Odysseus may be traced to the same root with ὀδύσσομαι, *to be angry*; but the tale by which his nurse Eurycleia is made to account for it throws a curious light on the process by which these stories grew up. According to this version, he was so named by his grandfather Autolycus, to express the hatred generally felt by men and women for the crimes and robberies of that chieftain. But the name, like that of LYCAON, and Lykios (Lycius), Lykegenes, as epithets of Phœbus, interprets itself as a mere name of the sun; and the wrath of Odysseus, like that of Achilles, is the gloomy time during which the sun is veiled by storm-clouds, as the glory of Odysseus was dimmed when he first entered his own hall.

Odyssey. The Homeric poem which relates the adventures of Odysseus on his return from Troy. This poem exhibits a much

greater unity of composition than the ILIAD, while it seems on the whole to be the work of a somewhat later age. But although there is throughout a unity of plan, the tale of the death of Achilleus, the longer lay of Demodocus, the episode of the solar herds in Thrinakia, with other passages, point apparently to a time when these, and perhaps other portions of the poem, existed in the form of separate lays. (Grote, *Hist. of Greece*, part i.; Mure, *Critical History of Greek Literature*; Gladstone, *Homer and the Homeric Age*; Cox, *Tales of Thebes and Argos*.) [ILIAD; EPIC.]

Œcumenical (Gr. οἰκουμενικός, *of the whole world*). In the Greek language, a term applied to ecclesiastical matters in the sense of *universal*. Several patriarchs of Constantinople assumed the title of œcumenical, apparently in opposition to the pretensions of the bishop of Rome. Œcumenical councils are those to which prelates resorted from every part of Christendom under the jurisdiction of the Roman empire. [COUNCIL.]

Œdema (Gr. οἴδημα). A puffiness or swelling of parts arising from water collecting in the cellular membranes.

Œdipus (Gr. Οἰδίπους). In the Mythology of Thebes, a son of Laios, who slays his father, destroys the Sphinx, and marries his mother Iocastê (Jocasta). The solar character of this legend is rendered evident on an examination of its details. The name of Iocastê belongs to the same family with those of Iolê, Iolaos, Iamos, Iobates, all expressing the violet colour. His father Laios, like Acrisios, Priam, and Aleos, dreads his own child, and exposes him on a mountain side. But, as Indra slays Dahanâ and the Night who bare him, so Œdipus must slay Laios at the beginning of his career, in which, like Heracles, Theseus, Perseus, and all other kindred heroes, he must slay a monster which oppresses the people of his land. This monster, the Sphinx, belongs to the same class with Python, Typhon, Fafnir, and Polyphemus. As in the mythology of the north Fafnir is the dragon of winter who encircles the treasures of the earth within his pitiless folds, so is the Sphinx the dark and lowering cloud, hanging over the earth during a time of drought, and heightening its agonies, until Œdipus, who alone knows her mysterious speech (as the sun was said to understand the mutterings of the thunder), hurls her from the hill on which she is seated, as the cloud, in Vedic language, smitten by Indra breaks into rain, and then vanishes away. As his reward, Œdipus is married to Iocastê; but Iocastê, instead of being the bride from whom he had been early parted, as Heracles was from Iolê, and Odysseus from Penelopê, is in the Theban myth his mother: and thus a vein of more modern ethical belief was introduced into the legend. The morality of men could not recognise a form of speech in which the same person might, with the interchangeable characters of the Vedic gods, be represented as at once the son and the husband of another. Hence the ERINYS of Laios is made to work an awful vengeance. Iocastê slays herself in her marriage chamber, and Œdipus tears out his eyes. The remainder of the tale is one of gloom and darkness, until in the last scene (in the company of Theseus, the solar hero of Attica), Œdipus goes forth to die amid the blaze of lightning in the sacred grove of the Eumenides. In his last hours, his eyes had rested on Antigone, the fair and tender light which comes across the eastern heaven as the sun sinks in the west. (Max Müller, *Comparative Mythology*.) But throughout the several incidents of his career, he was only fulfilling his doom. Heracles and Iolê must meet when the day is done; and hence arose the idea of that Ἀνάγκη, or invincible necessity [MOIRA], which in post-Homeric times came to be regarded as more powerful than Zeus himself.

The myth refers the name Œdipus to the swelling (οἰδέω, *to swell*) of the feet caused by the tight bandaging of his ankles when he was exposed on Cithæron. The story has much the same value with that in which Eurycleia accounts for the name ODYSSEUS. If the legend be right in referring it to οἰδέω at all, the idea conveyed is that of the swelling of the sun as it rises from a point of light to its full diameter above the horizon. For a more complete analysis of the story, see Bréal, *Le Mythe d'Œdipe*.

Œil de Bœuf (Fr. *bull's eye*). A small light formed in a roof for the purpose of lighting an attic, or a story in it. The small openings in a dome are also called by this name, as the yeux de bœuf of the dome of St. Peter's at Rome.

Œnanthe (Gr. οἰνάνθη). In Botany, a genus of *Umbelliferæ*, some species of which are poisonous. *Œ. crocata*, the Water Hemlock, found in wet ditches in this country, is one of the most virulent. Its roots consist of a number of thick, whitish, parsnip-like tubers, a resemblance which has been the cause of fatal accidents, since they act as an acrid narcotic poison. The plant is sometimes called by country people *five-fingered root*, and has some reputation as a remedy in diseases of the skin. *Œ. Phellandria*, *Œ. fistulosa*, and *Œ. pimpinelloides* are other common British plants. Some of the species produce innocuous tubers, which are eaten as food.

Œnanthic Ether. A peculiar compound, upon which the fragrancy and persistent odour of certain wines depend. It remains in the form of an oily liquid when large quantities of wine are distilled. By mixing it with an alkali and decomposing the mixture by sulphuric acid, a product is obtained which has been termed *œnanthic acid*. A solid substance called *œnanthic ether*, and used in Bavaria for flavouring inferior wines, was exhibited in the International Exhibition of 1862.

Œnanthol. A product of the destructive distillation of castor oil. When purified, it is a clear liquid of a peculiar pungent smell and taste.

Œnanthylic Acid. An acid of a peculiar aromatic odour, obtained by the action of nitric acid on castor oil or œnanthol; it also occurs in the fousel oil of maize spirit.

Œnometer (Gr. *οἶνος*, and *μέτρον*). A hydrometer adapted to the determination of the strength of wines.

Œnône. [PARIS.]

Œnothera (Gr. *οἰνόθηρας*). A genus of *Onagraceæ*, some showy species of which are cultivated in gardens under the name of Evening Primrose. The roots of *O. biennis*, the common evening primrose, eaten after meals, are said to be, like olives, incentives to wine-drinking.

Œnothionic Acid (Gr. *οἶνος*, and *θεῖον*, *sulphur*). An acid formed during the action of sulphuric acid upon alcohol. Sertuerner gave it the above name: it is the sulphovinic acid of other chemists.

Oerstedite. A silico-titanite of Zirconia, found at Arendal in Norway, in brilliant reddish-brown opaque or slightly translucent crystals, generally on crystals of Pyroxene. It is probably an altered Zircon. Named after the Swedish chemist Oersted.

Œsophagitis (Gr.). Inflammation of the œsophagus.

Œsophagotomy (Gr. *οἰσοφάγος*; *τέμνω*, *I cut*). The operation of cutting into the œsophagus, or gullet, for the purpose of removing some foreign substance.

Œsophagus (Gr. *οἰσοφάγος*, *the gullet*). The tube by which food is conveyed from the posterior part of the mouth, or *pharynx*, to the stomach. The gullet.

Œstrus (Gr. *οἶστρος*, *a gad-fly*). The name of a genus of Dipterous insects, some of which lay their eggs in the skin of quadrupeds, which they pierce for that purpose; others near the nose, up which the larvæ creep to the frontal sinuses. The flies of an allied genus (*Gasterophilus*) attach their eggs to the hairs in situations where they can be licked off and swallowed. As their vitality protects them from the action of the gastric juice, they are hatched in the stomach, and the larvæ attach themselves to the inner membrane, forming what are called *bots* in the horse.

Offa Helmontii. A term applied by some of the old chemists to carbonate of ammonia thrown down from its aqueous solution by the addition of alcohol.

Offcut. In Printing, that part of a printed sheet which cuts off, and which when folded is inserted in the middle of the other part, forming together a regular and orderly succession of all the pages in the signature.

Offerings (Lat. obfero, *I bring*). Literally, gifts presented at the altar in token of acknowledgement of the divine goodness. Offerings constituted a large portion of the Jewish worship. They consisted chiefly of bread, salt, fruits, wine, and oil, and had different names according to the purposes for which they were employed. A distinction has often been made between offerings and sacrifices [SACRIFICE]; the former being said to refer only to the fruits of the earth, the latter to animals; but this can scarcely have been the case, for both the burnt offering and the sin offering required animals to be sacrificed. Among the Greeks, Romans, and other nations, the same practice prevailed of offering at their altars wheat, flour, and bread. In a modern sense, the term *offering* is applied to certain ecclesiastical dues payable by custom, as the Easter offerings, &c. This latter custom has obtained from the first period of Christianity, when those who officiated at the altar had no other maintenance or allowance than the free gifts or offerings (oblationes) of the people.

Offertory. The first part of the Mass, in which the priest prepares the elements for consecration. In the office of the church of England communion, it denotes the sentences which are recited by the officiating priest while the people are making their oblations or offerings. (Palmer, *Orig. Liturgicæ.*)

Office Found. In English Law, an enquiry executed by some officers of the crown, when certain events have occurred in consequence of which the crown becomes entitled to take possession of real or personal property. Such are the finding of treasure under certain circumstances, the intestacy of a bastard, &c. The verdict of a coroner's jury of felo de se is an instance of office found, on which the crown is entitled to take possession of the effects of the deceased. There are many cases, however, both as to lands and chattels, in which the crown is entitled without office found.

Official (Lat. officium, *duty*). In the Canon Law, the deputy or lieutenant of a bishop, abbot, &c., or an ecclesiastical judge appointed by them. The principal official of the bishop is his chancellor, whose jurisdiction is coextensive with the diocese. An *officialis foraneus* (styled in English law *commissary*) is appointed to part of a diocese when large. The court of the official is styled in the canon law his *officiality*.

Officinal (Lat. officina, *a workshop*). In Pharmacy, such remedies as are directed by the *Pharmacopœia* to be kept in the apothecaries' shops.

Offing. A Nautical term, denoting a part of the sea at a considerable distance from the shore where there is deep water.

Offset. In Architecture, the upper surface left uncovered by the continuation of a wall above the place where the thickness diminishes, thus forming a ledge.

Offsets. In Gardening, a name given to young radical bulbs when separated or taken off from the parent roots; also short lateral shoots bearing clustering leaves at the extremity. One of the chief methods of propagating plants is by means of offsets. [PROPAGATION OF PLANTS.]

OFFSETS. In Surveying, short distances from the chain-line, usually measured with a rod, called an *offset staff*, the most convenient length for which is 6 feet 7·2 inches, being equal to 10 links of the surveying chain. [SURVEYING.]

A variety of Ripidolite, from Rauris in Upper Austria.

Ogee (Fr. ogive, Ital. augivo). In Architecture, the same as CYMA RECTA. [MOULDING.]

Oghams. A peculiar kind of shorthand writing in use among the ancient Irish. It consisted of certain lines and marks which derived their power from their situation and position, as they stood in relation to one horizontal principal line, over or under which they were placed, or through which they were drawn; the characters or marks, according to their position, standing in the place of vowels, consonants, diphthongs, &c.

Ogive or **Ogival** (Fr.). In Architecture, the term used by the French to express the arch struck from two centres.

Ogres (Fr.; Span. ogro, Ital. orco). The well-known name of those imaginary monsters with which the nursery tales of England abound. They are usually represented, like the Cyclops Polyphemus, as cannibals, of malignant dispositions, and as endowed with gigantic height and power. By some the term *ogre* is derived from Oegir, one of the giants in the Scandinavian mythology (Grimm's *Deutsche Mythologie*, p. 146); while others have thought that it has been borrowed from the Ogurs, or Onogurs, a savage Asiatic horde, which overran part of Europe about the middle of the fifth century. The Italian form of the word seems to point to the Latin *orcus* as its origin.

Ogygian Deluge. The name given to the flood of Deucalion, supposed to have taken place during the reign of Ogyges in Attica. [DELUGE.]

Oïdium (Gr. *οἰδέω, to swell*). The vine-mildew, a pest to which grapes, both in vineyards and hothouses, have of late years been subject, has been traced to the attacks of a kind of fungus which has been referred to this genus, *O. Tuckeri*. This plant is one of the naked-spored moulds. Mr. Berkeley, however, thinks that the Oïdium is an early stage of some *Erysiphe*. Sulphur is the only remedy which has, as yet, been discovered.

Oil of Bricks. A term applied by the old chemists to the empyreumatic oil obtained by subjecting a brick soaked in oil to the process of distillation at a high temperature. This oil is used by lapidaries as a vehicle for the emery by which stones and gems are sawn or cut.

Oil Cake. The residuum of various seeds after expressing the oil, especially of linseed and rape; it is used for cattle-feeding and as manure.

Oil Cups or **Lubricators.** Cups fitted to the bearing or frictional surfaces of an engine, for the purpose of lubricating them, and thus of diminishing the friction.

Oil Gas. The inflammable gases and vapours (chiefly *hydrocarbons*) obtained by passing fixed oils through red-hot tubes, and which may be used as *coal gas*, for the purposes of illumination. They yield a brilliant light, but too expensive to be generally adopted. The apparatus for the production of oil gas is described in the *Quarterly Journal of Science*, vol. viii. A gallon of common whale oil yields from 90 to 100 cubical feet of gas; and an Argand burner, giving the light of six or seven wax candles, consumes from 1½ to 2 cubical feet per hour; whereas, to produce the same light, from 5 to 6 cubic feet of coal gas are required.

Oil Painting. Painting in which the medium for using the colours consists partly of oil. Mere decorative work was often executed with oil colour, in the early middle ages; but Hubert and John van Eyck, early in the fifteenth century, were the first to substitute *oil* or *varnish* painting for *tempera*, in the execution of pictures. Oil painting has the advantages, above all other modes, of affording great delicacy of execution, a union and insensible blending of the colours, and above all that of imparting great force to its effects. The principal oils used are those extracted from the poppy, nut, and linseed. With the latter driers are introduced. A small quantity of oil only is necessary, the colours being tempered with turpentine, and with mastic or copal varnish. In repairing old oil pictures no oil should be used, as it darkens after a little time. The dry colours should be mixed with pure mastic varnish, and tempered in their application with turpentine. [PAINTING.]

Oil Seed. A name applied to the seeds of the Ram-til, *Guizotia oleifera*.

Oil of Vitriol. [SULPHURIC ACID.]

Oils (Ger. öl, Lat. oleum, Gr. ἔλαιον). The term *oil* is applied to several dissimilar and distinct organic products, such as *fixed* oils, *volatile* oils, and *mineral* oils. The fixed or fat oils are either of vegetable or animal origin; they are compounds of carbon, hydrogen, and oxygen, the relative proportions varying but little in the several species. The following analyses of olive and spermaceti oil may be assumed as types of the rest:—

	Olive Oil	Spermaceti Oil
Carbon	77·2	78·0
Hydrogen	13·3	11·8
Oxygen	9·5	10·2
	100·0	100·0

The *fixed oils* abound in the fruit and seed of certain plants; they are lighter than water, unctuous, and insipid, or nearly so. Some of these require a low temperature for their congelation, such as linseed oil; others, such as olive oil, concrete at a temperature higher than the freezing point of water; some are solid at common temperatures, such as cocoa-nut oil. Some of these oils when exposed to air absorb oxygen, and gradually harden, forming a kind of varnish; these are called *drying oils*, and are the vehicle of paints. Linseed oil is one of this kind. Others become rancid, as almond oil. All these oils, like the different kinds of fat, consist of two proximate principles, called *stearin* and *olein*: the former is the fatty portion, which

first concretes on cooling the oil, and from which the olein, or oily portion, may be separated by pressure. These oils cannot be volatilised without decomposition. At a red heat they are resolved into volatile and gaseous products, among which hydrocarbons of various kinds predominate; hence the use of these oils, when volatilised and burnt by the aid of a wick, as sources of artificial light. The action of the alkalies on the fat oils is highly important in the manufacture of soap.

The *volatile oils* are generally obtained by distilling the vegetables which afford them with water. They fluctuate in density a little on either side of water: they are sparingly soluble in water, forming the perfumed or medicated waters, such as rose and peppermint water, but are mostly soluble in alcohol, forming essences. A few, such as oil of turpentine, of lemon peel, of capivi balsam, &c., are hydrocarbons, i. e. they consist of carbon and hydrogen only; the greater number, however, contain oxygen as one of their ultimate elements. They are chiefly used in medicine and in perfumery, and a few of them are extensively employed in the arts as vehicles for colours, and in the manufacture of varnishes; this is especially the case with oil of turpentine.

The term *mineral oils* is applied to a number of oily bodies derived from lignite and bituminous bodies either by natural or artificial distillation. These oils are used partly for lubrication, but chiefly for illumination. One of the most important of the materials manufactured from these sources is paraffin oil, the production of which from Boghead cannel coal has been carried out on an immense scale by Mr. Young, of Bathgate, near Edinburgh.

But this artificial mineral oil has recently encountered a formidable rival in native *coal oil*, or *rock oil*, which has been distilled by nature herself, and consequently does not require those preliminary processes which oil produced from bituminous coal has to undergo. These discoveries have been made principally in the United States of America, and more especially in Canada. In the latter country alone no less than twenty million gallons of this oil have been obtained from wells, several of which are spouting wells. From these the oil rises, probably from the pressure of gas, to a considerable height above the surface of the ground, so as not to require pumping. The twenty millions of gallons, which represent the annual production of the Canadian wells, may, upon a moderate calculation, be said to furnish, in refined oil alone, illuminating material equal to one hundred and eighty millions of pounds of sperm candles.

The importance of such a vast amount of illuminating material so cheaply obtained can scarcely be overrated in connection with the question of the production of artificial light. Up to the present time, the refined oil from this crude petroleum has been prevented from coming into effective competition with the original paraffin oil, owing to the carelessness with which the former has been manufactured. There is a considerable portion of light naphtha left in this oil, which renders it capable of forming explosive mixtures in the lamps wherein it is burnt. Both these American oils require to be still further freed from volatile naphtha. They would then form valuable illuminating materials. From an economical point of view, the rock oil and the paraffin oil approach gas much more closely than any other illuminating agent hitherto invented; while the enormous quantities in which these oils are now being produced cannot fail to make them still lower in price. They may consequently be regarded as very formidable rivals of gaslight.

Oillets, Oylets. In Mediæval Architecture, the term *oillets* is applied to the small openings, or loopholes (sometimes circular), through which in mediæval fortifications missiles were discharged against the enemy.

Oisanite. A name for Anatase (oxide of titanium), from its chief locality, Bourg d'Oisans in Dauphiny.

Okenite. A hydrated bisilicate of lime, composed of 28 per cent. of lime, silica 62, and water 18. It generally occurs in delicately fibrous and sometimes in radiating masses, of a snow-white colour, with a tinge of yellow or blue. It is very tough. It is found in Disco Island; Tupaursak in North Greenland, in amygdaloid; also in Faroe, Iceland. Named after Professor Oken.

Olacaceæ (Olax, one of the genera). A natural order of hypogynous Exogens belonging to the Berberal alliance, and distinguished by its valvate regular symmetrical flowers, its axile placentæ, its stamens alternating with the petals, and its pendulous ovules. It consists for the most part of tropical shrubs.

Olanin (Lat. oleum, *oil*). One of the ingredients of the fetid empyreumatic oil obtained by distilling bone and some other animal matters.

Old Red Sandstone. The name formerly given by English geologists to a group of sandstones, often of a red colour, and lying beneath the carboniferous limestones in some parts of Herefordshire and South Wales. The name was adopted in contradistinction to that of New Red Sandstone, from which the Old Red is separated by the carboniferous series. The old red sandstone in its typical character exists not only in the places named, but in Scotland and in Russia; in other countries it is so different in mineral character that the name is quite inapplicable. The rocks, whatever they may be, of this date are now more generally called Devonian [which see].

The typical *old red* consists of (1) yellow and red sandstones and impure limestones, sometimes magnesian, together called the *Old Red Conglomerate*; (2) a sandstone or grit occasionally used for flagstone; (3) variegated sandstones and bituminous schists overlying a coarse grit and conglomerate.

Old Testament. The name given to the Hebrew Scriptures. The period of their being

collected is unknown. Some of them were in existence before the Babylonish captivity (600 years B.C.); others were collected at a later period; and the collection as it at present stands was completed in the second century before Christ. The Jews divided the Old Testament into the Law, the Prophets, and other writings known by the name Hagiographa, of which the Psalms were at the head. The contents of the Old Testament may be conveniently divided into the Historical Books, of which there are seventeen; the Poetical, of which there are five; and the Prophetical, of which there are sixteen, distinguished into the books of four greater and twelve minor prophets. The Historical Books include the Pentateuch, the Books of Joshua, Judges, Ruth, two Books of Samuel, two Books of Kings, two Books of Chronicles, the Books of Ezra, Nehemiah, and Esther. The Poetical Books include the Book of Job, the Psalms, the Proverbs, Ecclesiastes, and the Song of Solomon; and the Prophetical comprise (of the greater) Isaiah, Jeremiah, Ezekiel, and Daniel, and (of the minor) Hosea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakkuk, Zephaniah, Haggai, Zechariah, and Malachi. [APOCRYPHA; BIBLE; BIBLICAL HISTORY; TESTAMENT; PROPHETS; PSALMS; &c.]

Oldfieldia (after Mr. R. A. Oldfield). A species of this genus of *Euphorbiaceæ*, called *O. africana*, has been ascertained to furnish the African Oak or African Teak, a hard wood said to be one-third stronger than English oak or Malabar teak, but so ponderous that it cannot be used alone for such purposes as ship-building. The heartwood is very durable in places where there is a free current of air, but in confined situations it is apt to decay.

Olea (Lat.). A genus of trees belonging to the *Oleaceæ* and the Linnæan *Diandria Monogynia*. The *Olea europæa*, or Common Olive, has an upright stem, with numerous branches, grows to the height of twenty or thirty feet, and differs from most trees in yielding a fixed oil from the pericarp instead of from the seed.

The Olive-tree has in all ages been held in peculiar estimation; and some authors have styled it a *mine upon earth*. It was sacred to Athena. [MINERVA.] Olive wreaths were used by the Greeks and Romans to crown the brows of victors; and it is still universally regarded as emblematic of peace. The olive flourishes only in warm and comparatively dry parts of the world, as in the South of France, in Spain, in Italy, Syria, and the north of Africa; and though it has been grown in the open air in this country, its fruit dees not ripen. The fruit is a smooth oval plum, about three-quarters of an inch in length, and half an inch in diameter, of a deep violet colour when ripe, whitish and fleshy within, bitter and nauseous, but replete with a bland oil. Olives intended for preservation are gathered before they are ripe. In pickling, the object is to remove and to preserve them green, by impregnating them with a brine of aromatised sea salt; and for this purpose various methods are employed.

It is chiefly, however, for the sake of its oil that the olive-tree is cultivated. Olive oil is pale yellow; its density is ·910. When fresh, and of fine quality, it is almost tasteless, having only a very slight and agreeable nutty flavour. It is less apt than most other fixed oils to become viscid by exposure, and hence is preferred for greasing clock and watch work. It is largely used as an article of food. It is the principal article of export from the kingdom of Naples. The quantity of olive oil imported into England in 1863 was 19,866 tons, of the computed value of 1,138,336*l*. In 1864 the quantity was somewhat less. There was formerly a duty of eight guineas a ton on olive oil, but it is now admitted free.

Oleaceæ (Olea, one of the genera). The natural order of plants which contains the Olive-tree and the Ash. It belongs to the Solanal alliance, and consists of trees or shrubs inhabiting the temperate parts of the world, and distinguished from others by their flowers being monopetalous and diandrous, with a valvate æstivation.

Oleander. [NERIUM.]

Olecranon (Gr. ὠλέκρανον). The head of the ulna. The process of the ulna which forms the elbow.

Olefiant Gas. *Ethylene.* This variety of carburetted hydrogen may be obtained by heating a mixture of two measures of sulphuric acid and one of alcohol. It is of somewhat less specific gravity than atmospheric air, 100 cubic inches weighing 30·5 grains. It burns with a bright white flame, and produces during combustion such proportions of carbonic acid and water as show that one volume of the gas is constituted of two atoms or volumes of hydrogen and two atoms of carbon; in two volumes, therefore, it contains four atoms of carbon and four of hydrogen, its formula being C_4H_4.

When two volumes of chlorine are mixed with one of olefiant gas, and inflamed, hydrochloric acid is formed, and the carbon of the gas makes its appearance in the form of dense black soot. If the mixture, instead of being kindled, be left standing over water, it soon condenses into a liquid looking like oil (hence the term *olefiant gas*), which is dichloride of ethylene. It has an aromatic odour, not unlike that of oil of caraways.

Oleic Acid. ($C_{36}H_{34}O_4$.) This acid is obtained by saponifying almond oil with potash, and decomposing the soap by hydrochloric acid, which separates a mixture of oleic acid and margaric acid: this, by digestion with oxide of lead, is converted into oleate and margarate of lead, and by digesting these in ether, an acid oleate of lead is dissolved. The ethereal solution is mixed with its bulk of water and decomposed by hydrochloric acid, which throws down chloride of lead, and leaves the oleic acid in solution, from which it is obtained by evaporation. The crude oleic acid, produced by pres-

sure in the manufacture of stearine candles, may be similarly purified.

Oleic acid is colourless, concretes at about 50°, and reddens litmus; it is insoluble in water, but abundantly soluble in alcohol. The neutral oleates have little tendency to crystallise. The soluble alkaline oleates are soft fusible compounds, more soluble in alcohol than in water, and are decomposed by excess of water, into free alkali, and acid compounds.

Olein (Lat. oleum, *oil*). ($C_{114}H_{104}O_{12}$.) *Oleate of glycerine.* Olein is the principal ingredient in the fat oils which remain fluid at common temperatures. It is procured by separating the palmitin and stearin from a fat oil, by cold and pressure, dissolving the liquid portion in ether, evaporating, and digesting the residue in cold alcohol, which dissolves the olein, and leaves palmitin and stearin undissolved. Olein is colourless, inodorous, and tasteless; its specific gravity is about 0·9. It is insoluble in water, but abundantly soluble in alcohol and in ether. It remains fluid at 32°.

Oleophosphoric Acid. A fatty acid containing phosphorus, and forming one of the proximate components of the yolk of eggs and of the brain. In combination with soda it occurs in other parts of the body, its quantity increasing with the age of the animal. Fishes with tender white flesh (whiting, sole, plaice, &c.) contain less of it than is found in those of a firmer muscle (salmon, trout, herring, mackerel, &c.). [CEREBRIC ACID.]

Oleosaccharum (Lat. oleum, and saccharon, *sugar*). In Pharmacy, powdered sugar mixed or imbued with certain essential oils; called also *Elæosaccharum.*

Oleraceous. In Botany and Horticulture, a term applied to plants having esculent properties; i.e. to such as are fit for kitchen use, or having the nature of a potherb.

Oleron, Laws of. [MARITIME LAW.]

Olfactory Nerves. The nerves of smell. The first pair of nerves. They arise from the part of the brain called the *corpora striata*, and, perforating the ethmoid bone, are distributed over the mucous membrane of the nose.

Olibanum. A gum resin, imported from the Levant, in yellowish white and nearly opaque drops or tears; it has a bitterish flavour, and has been used in medicine. When burnt, it exhales rather an agreeable odour, and is sometimes called *frankincense.* Indian Olibanum is the produce of *Boswellia thurifera*, and African Olibanum of *B. papyrifera.*

Oligarchy (Gr. ὀλιγαρχία). A state in which the sovereign power is lodged in the hands of a small exclusive class. It differs from aristocracy, in that the latter term appears to designate a government in which the whole of a particular class or interest, e.g. the noble, the wealthy, &c., share directly or indirectly in the management of public affairs; while, in an oligarchy, it is a party or section formed out of one of these classes which enjoys the advantages of government.

Oligoclase (Gr. ὀλίγος, *little*, and κλάω, *to cleave*). A soda-Felspar. It is a silicate of soda and alumina, composed of 62·3 per cent. of silica, alumina 23·5, and soda 14·2. It is white, with a tinge of grey, green, yellow, or red, and is more or less translucent. The crystals, which often occur in twins, resemble those of Albite. It is found in Teneriffe in trachyte; and in granite at Kimito, near Stockholm; also at Arendal in Norway, Arriège in France, Haddam in Connecticut, Siberia, &c.

Oligon Spar. A variety of Sparry Iron-ore, containing twenty-five per cent. of protoxide of manganese; found at Ehrenfriedersdorf, in Saxony.

Oliva (Lat. *an olive*). A genus of Pectinibranchiate Gastropods, dismembered from the *Volutes* of Linnæus, and so called on account of the long, elliptical shape of the shell. The aperture is narrow, long, and notched opposite to the spire, which is short; the folds of the columella are numerous, and resemble striæ. The animal has a large foot, the anterior portion of which is marked off by an incision on each side. The horns or tentacula are slender, and the eyes are on the middle of their outer side. The proboscis and the breathing tube are tolerably long; there is no operculum. The species of *Oliva* rival the cowries in beauty.

Olive. [OLEA.]

Olive Copper-ore or **Olivenite.** A hydrated arseniate of copper of an olive-green colour, the finest specimens of which have been found in Cornwall.

Olivine. The name applied to varieties of *Chrysolite* of inferior colour and clearness. It occurs in yellowish-green or olive-coloured masses and grains embedded in basalt and lava, as in the basalt of the Giant's Causeway in Ireland, the trap rock of Arthur's Seat near Edinburgh, the lavas of Unkel on the Rhine, and in those of the Sandwich Islands. It is also sometimes found associated with meteoric iron. Olivine is an anhydrous silicate of magnesia and protoxide of iron, and is very difficult of fusion.

Olla Podrida (Span. *putrid mixture*). The name given to a favourite dish of all classes in Spain; consisting of a mixture of all kinds of meat cut into small pieces, and stewed with various vegetables. The epithet *podrida* is applied to this dish, in consequence of the poorer classes being obliged to serve it up so often that the odour arising from long keeping is far from agreeable. The phrase *olla podrida* is often used metaphorically in England for any incongruous mélange.

Olympiad (Gr. ὀλυμπιάς). In Chronology, a Grecian epoch of four years, being the interval between the celebration of the Olympic games.

Before the introduction of the Metonic cycle, the Olympic year began sometimes with the full moon which followed, sometimes with that which preceded, the summer solstice. Subsequent to the introduction of that cycle, the year always commenced with the eleventh day

of the moon which followed the solstice, and it is usually regarded as beginning on the first day of July. It is necessary to observe, in the comparison of dates, that as the Olympiads begin about July 1, the first six months of a year of our era correspond to one Olympic year, and the second to another. The first year of the first Olympiad began 776 years and six months before our era; hence, in order to reduce the date by Olympiads to our era, the rule is this: Multiply the number of the past Olympiad by four, and add the odd years; subtract the sum from 777, if before Christ, or subtract 776 from the sum, if after Christ: the remainder will be the year before Christ or after Christ, if the event happened in the first six months of the Olympic year, i.e. between July and January; but if the event happened in the last six months of the Olympic year, or between January and July, the remainder in either case must be diminished by one. For example: the foundation of Rome (according to Varro) was laid in the third year of the 6th Olympiad, and 10th month of that year; required the date? Here 5 complete periods are elapsed; therefore, $5 \times 4 + 3 = 23$; and $777 - 23 = 754$, which being diminished by 1 gives 753 B.C. for the date. The month corresponds to April.

The method of computing time by Olympiads did not come into use till after the death of Alexander; it first appears in the Parian Chronicle, which was engraved about sixty years after that event. The first historian who used it was Timæus Siculus, who wrote a few years later. About 200 years B.C. Eratosthenes of Alexandria digested a chronological table of the Olympiads.

Olympic Games. The greatest of the national festivals of Greece, celebrated once every four years at Olympia, or Pisa, in Elis, in honour of the Olympian *Zeus* (Jupiter).

These games were said to have been instituted about 1354 years before the Christian era: and, having fallen into disuse, to have been revived by Iphitus, king of Elis, 844 years B.C. About a hundred years later, it is said, the practice was introduced of designating the Olympic period by the name of the victor. The first who received the honour was Corœbus, and the commencement of the Olympiad of Corœbus forms the principal era of Grecian chronology. The games in which he was said to be the victor were celebrated about the time of the summer solstice, 776 years before the era of the Incarnation, in the 3938th of the Julian period, and 23 years, according to the reckoning of Varro, before the foundation of Rome. But the historical value of this first recorded Olympiad is very small. The inscription refers to a time nearly three centuries earlier than the rise of contemporary history; and we have no means of verifying the indispensable fact that it was made at or about the time of the events which it commemorates. (Grote's *History of Greece*, part i. ch. xix.)

Like the other public festivals, the Olympian games might be attended by all who bore the Hellenic name; and such was their celebrity, that spectators crowded to witness them, not only from all parts of 'continuous Greece' (Ἑλλὰς συνεχής), but from every Greek colony in Europe, Asia, and Africa (Ἑλλὰς σποραδική). In these games, none were allowed to contend but those who could prove that they were freemen of genuine Hellenic origin, and unstained by crime or immorality. The superintendence belonged sometimes to the Pisans, but for the most part to the Eleans, by whom the Pisans were subdued. On one occasion, in the one hundred and fourth Olympiad, the management was forcibly seized on by the Arcadians. The contests at these games consisted in athletic exercises, and also in those of music and poetry. The orators were crowned with garlands of wild olive. The place where these renowned games were celebrated is a plain, now called Anti-Lalla, opposite the little town of Lalla. See a recent careful description of it in Sir Thomas Wyse's account of his tours in the Peloponnesus. The games commenced a little after the summer solstice, on the 14th of the Attic month Hecatombæon.

Omander Wood. The name of a kind of Calamander wood obtained from *Diospyros Ebenaster*. It comes from Ceylon.

Ombria (Gr. ὄμβρος, *rain*). A name formerly applied to certain fossil Echini, under the supposition of their having fallen from the clouds.

Ombrometer (Gr. ὄμβρος, *rain*; μέτρον, *measure*). A name sometimes given to the RAIN-GAUGE.

Omens (Lat. omina). Casual indications, from which men believe themselves enabled to conjecture or foretell future events. The essential characteristic of all omens is their happening by accident; and it is this which distinguishes them from all other modes of divination. This branch of superstition seems nearly as ancient as the world itself; and in none do we find such remarkable indications of sameness of origin. Many external circumstances appear to be received in almost all countries as ominous. The omens in which the Thugs, or secret murderers of India, trust with peculiar devotion, are almost the same which an ancient Roman would have observed with equal attention, especially the appearance of animals on the right or left hand. In classical antiquity, however, omens appear to have multiplied, and to have been the subjects of more curious superstition in later than in earlier ages. There are numberless omens in Homer; but they are generally of the simplest description: thunder and lightning; the appearance of some sacred birds, especially, as some critics have observed, those which have the highest flight, and might be supposed to have arrived immediately from the throne of Jove himself. Omens, among the Greeks (and, we may add, among almost all nations in periods of ignorance, and among the vulgar of the present day), may be di-

vided into three classes: those derived from natural occurrences, relating to inanimate objects, lightning, earthquakes, phosphoric appearances, &c.; those derived from animals, especially birds, the region of their appearance, their voices, &c.; and those which the individual drew from sudden sensations of his own. Sneezing, in most times and countries, has been a peculiarly ominous occurrence. The Romans, as is well known, carried the science of omens to a very profound depth: the flight of birds was the main element in *augury*; the omens afforded by the entrails of sacrificed animals, in the learning of *extispicium*. In Greek divination, the right hand denoted good luck, and the left the contrary. Among the Romans this rule was reversed, although their writers in later times often adopt the Greek mode of expression. This difference of practice arose from the position of the augurs at the time of taking the omens. In both systems the good omens came from the east; but the Greek augurs faced the north, and hence had the east on the right hand, whilst the Romans faced the south, thus having the east on the left hand. [AUGURS.]

Omentum (Lat.). This membrane is formed of a duplicature of the peritoneum, and encloses more or less fat. It is attached to the stomach, and lies on the anterior surface of the intestines.

Ommiad Caliphs. [MOHAMMEDANISM.]

Omnium (Lat. *of all*). In Finance, a term used in the Stock Exchange, to denote the various kinds of stock created when a loan is negotiated. Up to the year 1799, it was the general practice of the government, when it borrowed money, to provide for the gradual extinction of part of the debt, by the creation of consols for the greater part, by that of a stock bearing a high rate of interest, which might at a subsequent period be lowered, and by the grant of long or short annuities, the effect of this rule being to lay a larger share of the burden on the immediate borrowers. During the course of the transaction, speculations were made in the purchase and sale of these stocks jointly, which were called *omnium*, because the premium or discount was calculated upon the whole together. The excuse for abandoning the custom of creating omnium, severely censured at the time, was found in the enormous loans negotiated, and the comparative ease of creating a single stock.

Omnivora (Lat. omnivorus, *all-devouring*). The name given by Temminck to an order of birds, including those Insessorial species which feed on both animal and vegetable substances: as the starling.

Omohyoideus (Gr. ὦμος, *the shoulder*; and Ὑοειδές, sc. ὀστοῦν, *a bone*, shaped like the letter Υ). A muscle which pulls the os hyoides obliquely downwards: it is sometimes called the *coracohyoideus*: it arises from the superior costa of the scapula, and is inserted into the base of the os hyoides.

Omphalobium (Gr. ὀμφαλός, *a navel*, and λόβος, *a pod*). This genus of *Connaraceæ* is stated, on the authority of Sir R. Schomburgk, to yield the ornamental wood called Zebra wood, the species from which it is obtained being *O. Lambertii*, one of the trees of the Guiana forests.

Omphalodium (Gr. ὀμφαλός). In Botany, the centre of the hilum of a seed, through which the nourishing vessels pass from the placenta into the seminal integuments.

Omphalotomy (Gr. ὀμφαλητομία). The division of the navel string.

Omphazite. A foliated leek-green variety of Pyroxene, found accompanied by Garnet, with which it forms the rock called Ecklogite, at the Sau Alp in Carinthia.

Onagraceæ (Onagra, an old name for the genus *Œnothera*). An extensive natural order of polypetalous Exogenous plants belonging to the Myrtal alliance, very common in gardens, where they are much valued for the beauty of their flowers. They are known by all the parts of their flowers being arranged in fours. The genera *Fuchsia*, *Œnothera*, and *Epilobium* are common illustrations of the order.

Oneirocritics (Gr. ὀνειροκριτικός, from ὄνειρος, *dream*, and κρίνω, *I judge*). The science of interpreting dreams: treated of by Artemidorus, Macrobius, and other classical writers; by Thomas Aquinas, and others of the schoolmen; and, among many other moderns, by Cardanus, and Maio, a Neapolitan philosopher. According to all these writers, the secret of oneirocritical science consists in the relation supposed to exist between the dream and the thing signified; but, far from keeping to the relations of agreement and similitude, they frequently have recourse to others of dissimilitude and contrariety.

Oneirodynia (Gr. ὄνειρος, and ὀδύνη, *pain*). Disturbed dreams, including the nightmare and somnambulism.

Onicolo or **Nicolo.** A variety of Onyx, used for making cameos.

Onion (Fr. oignon). The *Allium Cepa* of botanists, one of the most useful and extensively employed of the esculent alliaceous or garlic-flavoured plants. What is called Welsh Onion, a perennial bulbless kind sometimes seen in gardens, is *Allium fistulosum*.

Oniscidæ. The name of a family of Isopodous Crustaceans, of which the wood-louse (*Oniscus*) is the type.

Onkosin. A kind of clay of an apple-green or brownish colour, which occurs in roundish pieces at Possеggen in Salzburg.

Onobrychis (Gr. ὄνος, *an ass*; βρύχω, *to gnaw*). [SAINFOIN.]

Onofrite. A native selenio-sulphide of mercury, found with other ores of mercury near San Onofre in Mexico.

Onomasticon (Gr. from ὄνομα, *a name*). A work containing words or names, with their explanation, arranged in alphabetical or other order; a dictionary, commonplace book, &c. The best known work under this title is the *Onom.* of Julius Pollux, in ten books, a valuable repertory of ancient philological learning.

a (Gr. ὀνοματοποίησις). Literally, the making or manufacture of names; a word expressing by its sound the thing represented. In most languages the cries of animals are thus expressed; and the line of Aristophanes,

Ὁ δ' ἠλίθιος ὥσπερ πρόβατον βῆ βῆ λέγων βαδίζει,

shows that the modern Greeks have not correctly retained the sound of the eta (which they pronounce like our e), as the sound imitated from nature would not be thus represented. Ennius imitated the sound of a trumpet by the word *taratantara*; and, to represent the croaking of frogs, Aristophanes used βρεκεκεκὲξ κοὰξ κοάξ. (*Frogs* i. 209.) Greek and German are peculiarly rich in words of this description. M. Charles Nodier has published a dictionary of those in French. For the onomatopoetic theory, as affecting the formation of articulate speech, see LANGUAGE.

Ononine. A sweet crystalline principle contained in the root of the *Ononis spinosa*.

Onopordon. A genus of Thistles, represented in this country by *O. Acanthium*, the Cotton Thistle, a rather common, wayside weed, which is one of the plants regarded as the Thistle of Scotland. It is a stately plant, with broad, spiny-edged leaves, white with cottony hairs, and large prickly flower-heads of a dull purple colour.

Ontology (Gr. τὸ ὄν, *being*, and λόγος). The science of *being* in itself, or its ultimate grounds and conditions. [METAPHYSICS.]

Onus Probandi (Lat. *the burden of proving*). In Law, the obligation of adducing evidence. The *onus probandi* is said to lie generally on that party who asserts the affirmative of the question in dispute, according to the rule, 'Ei incumbit probatio qui dicit, non qui negat.' It may be shifted, in many instances, from one litigant to another, by the establishment of a primâ facie case against a party.

Onychia (Gr. ὄνυξ, *the nail*). A whitlow.

Onychoteuthis (Gr. ὄνυξ, *a claw*; τεῦθος, *a calamary*). The name of the genus of Calamaries in which the suckers of the cephalic appendages are armed with a hook.

Onyx (Gr. ὄνυξ, *a nail*). A variety of Chalcedony, somewhat resembling Agate. It is composed of alternating parallel bands of different colours, and was the stone used by the ancients for making cameos, the figures being cut in the white layers, while the darker portion formed the background of the design. Large numbers of these stones are brought from Oberstein in Saxony, and from Yemen in Arabia; it is also found in the Isle of Skye, and in the amygdaloid of the Giant's Causeway in Ireland.

ONYX. In Surgery, an abscess of the cornea of the eye; so called from its resemblance to the stone termed an onyx.

Oolite (Gr. ᾠόν, *an egg*, and λίθος, *a stone*). A limestone made up of small round particles like the eggs or roe of fish. It is sometimes called *roestone*. Limestones of this kind being especially abundant in England and characteristic of the middle secondary rocks, have long been recognised as the OOLITIC SERIES. On the continent of Europe (where, except in the North of France, the oolitic structure is not retained) the contemporaneous rocks are better ... Oolitic limestones are ... of the carboniferous series and in tertiary f...

The cause of the singular structure of oolites has ... It is almost invariably the case that ... minute particle of organic matter is in the centre of each little egg-shaped atom of the stone. Round this nucleus are numerous layers of the finest lime mud mixed with a little clay. The arrangement is mechanical, and may have been induced by a slight ripple in shallow water loaded with carbonate of lime, which was thus deposited in exceedingly minute particles on the fragments of lime sand (broken shell and coralline) which covered the shore. The slight mechanical disturbance of the water may have been the reason why the carbonate of lime was deposited in each separate grain and not in one compact mass.

The oolites were probably formed in a district where there was a slow subsidence of the sea bottom, and where carbonate of lime was in excess in the water. When the eggs composing a limestone are larger than a pin's head, the rock is called PISOLITE.

Oolitic Series. An important division of the middle secondary or Mesozoic rocks of England. Regarding the oolitic series as forming three groups, the upper, middle, and lower, the great oolite is a member of the upper part of the lower group. It abounds with admirable but soft building stones in the West of England; and in Yorkshire, Lincolnshire, and Northamptonshire it contains very important deposits of ironstone. In some places it passes into hard blue limestones extremely durable. The celebrated limestones of Caen correspond with it in geological age.

The rocks of the so-called oolitic series in England are greatly subdivided. There is first a general grouping into upper, middle, and lower, and then a further grouping of the subdivisions.

The following may be taken as representing the most important:—

Upper Oolites		Purbeck beds.
		Portland sand.
		Portland stone.
		Kimeridge clay.
Middle Oolites		Calc grit.
		Coral rag.
		Oxford clay.
		Kelloway rock.
Lower Oolites	A	Cornbrash.
		Forest marble.
		Bradford clay.
		Great oolite.
		Stonesfield slate.
	B	Fuller's earth.
		Inferior oolite, or Dundry beds.

The general appearance of the oolites of England is that of three ridges running north-north-east and south-south-west, with three extensive and rich plains, two between the ridges, and one to the west. The ridges are escarpments of the hard limestone beds (Portland, coral rag and lower oolite), while the plains are occupied by the less coherent clays and shales alternating with them (Kimeridge clay and Oxford clay). The lowest deposits lap over the great plains of the lias to the west, and on the east the lower greensand forms a poor escarpment covering them. In the centre of England the upper beds are absent, in the west the whole sequence is nearly perfect, in the south the lower limestones make the principal escarpment, and in the north the central beds are chiefly developed. In the south-east the Wealden deposits intervene between the oolitic and cretaceous series.

The oolitic series is extremely important in England, inasmuch as it yields all through our island a vast quantity of excellent freestone and beds of ironstone of great value. It is also interesting in the highest degree for its fossils, which are numerous, varied, and in excellent condition. Among the most interesting of the fossils are remains of several quadrupeds found in the Stonesfield slate. There are also numerous reptiles, some of them of the most gigantic proportions, both carnivorous and herbivorous, and one group analogous to the larger bats and generally inhabiting the air. [MEGALOSAURUS; IGUANODON; PTERODACTYL.]

Oolysis (Gr. ὠόν, *an egg*, and λύσις, *a setting free*). In Botany, a term applied to monstrous ovular developement.

Oosite. A mineral resembling Pinite, from the porphyry of Oos in Baden.

Oosporangia (Gr ὠόν; σπορά, *seed*; and ἀγγεῖον, *a vessel*). In Botany, the smaller of the two kinds of zoospores, which occur in some of the dark-spored *Algæ*; they are regarded by Mr. Berkeley as a transition between spermatozoids and minute zoospores.

Oozoa (Gr. ὠόν, and ζῶον, *animal*). A name applied by Ficinus and Carus to a primary division of the animal kingdom, including those in which the nervous and sanguiferous systems are incompletely developed, and in which the organisation resembles the simple condition of the ovum of the higher classes. This division corresponds to the *Acrita*.

Opacity (Lat. opacitas, from opacus, *dark*). In Optics, that quality of bodies which renders them opaque, or incapable of transmitting light. It seems to depend upon the nature or disposition of the particles of bodies, but its precise cause is, at present, far from being understood. According to Newton, opacity may arise from the unequal densities of the particles of certain substances, in consequence of which the rays of light on entering those substances suffer such refractions and reflections as compel them there to remain, and cause them to be finally absorbed, while, in bodies of a homogeneous nature, as glass, diamond, &c., the light experiences so much less of these irregular actions, that, except when the thickness of the medium is very great, it is enabled to pass quite through them.

The entire absorption of all the light which enters a substance, merely by the multiplied refractions or reflections which it undergoes within the mass, is difficult to conceive, and the advocates of the undulatory theory ascribe opacity to the unfitness of the pores, or intervals between the molecules of a body, for permitting the vibrations of the particles of ether, without disturbing the molecules, which thus appropriate to themselves the vis viva which would otherwise have belonged to the transmitted ethereal vibrations. The same persons consider transparency to consist in such a disposition of the molecules of a body that the incident waves of ether can be propagated with a certain degree of freedom through the mass; some impediment to the propagation of the waves may exist in the most transparent substances; and hence when such substances have more than a certain thickness, the waves cease to be transmitted through them. (*English Cyclopædia*, 'Arts and Sciences.')

Opal (Lat. opalus, Gr. ὀπάλλιος). A beautiful mineral characterised by its iridescent reflection of light. It is a kind of amorphous silica, containing between five and ten per cent. of water, mechanically mixed with it. *Common Opal* in some of its characters resembles the Precious or Noble Opal; but it has no play of colours, and is more abundant, the former being a very rare mineral. Opal is found in veins in porphyry and in vesicular cavities in amygdaloid, chiefly in Hungary, Mexico, the Faroe Islands, and Iceland. (Pliny, *Natural History*, lib. xxxvii. 6.)

Opal-Jasper. A kind of Opal containing a large amount of iron-oxide.

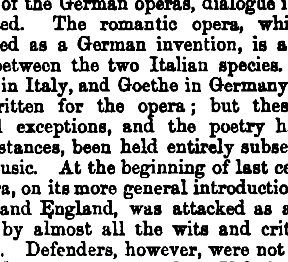
Openings. In Architecture, the piercings, or unfilled parts in a wall, left for the purpose of admitting light, air, &c. In Civil Engineering, the openings are often left for the purpose of diminishing the weight that would otherwise press upon the foundations, or for the purpose of economy in the structure. There can be no rule for calculating the proportion of the solid to the openings; the only invariable principle in settling them, is to make them always immediately over one another, *solids over solids, voids over voids.*

Opera (Ital.). A musical drama, in which the music forms an essential part, and not merely an accompaniment. The whole dramatic art of the ancients possessed much of an operatic character. The choric parts were sung; and if the dialogue was not carried on in the musical tone termed *recitative* in modern times, it was certainly delivered in an artificially raised and sustained key, very different from the ordinary or oratorical speech. The first operas in modern times were performed in Italy, about the end of the fifteenth century. The *Orpheo* of Poliziano has been cited as the

first complete piece of this sort. Jean Antoine Bäif introduced the opera into France, where the earliest representation of this kind is said to have taken place at the marriage of the duc de Joyeuse, in 1582. In 1707, the opera of *Arsinoe*, consisting of English words adapted to Italian airs, was performed at Drury Lane, and a succession of entertainments of this kind terminated in the Italian opera. The first attempt at a wholly English opera was made by Sir William Davenant, in 1656. The opera is divided into *seria* and *buffa*, according to the subjects and the character of the music; and between the limits of both there is a third species, or *mezzo stile*, not very accurately definable. The opera, properly speaking, admits only of singing and recitation, although, in some of the German operas, dialogue is also introduced. The romantic opera, which is considered as a German invention, is a compound between the two Italian species. Metastasio in Italy, and Goethe in Germany, have both written for the opera; but these are splendid exceptions, and the poetry has, in most instances, been held entirely subservient to the music. At the beginning of last century the opera, on its more general introduction into France and England, was attacked as an absurdity by almost all the wits and critics of the day. Defenders, however, were not wanting; and foremost among them Voltaire came forward with an apology for the opera in the preface to his tragedy of *Œdipe*.

Opera-glass. A small telescope used in theatres, whence it has its name.

The common opera-glass is simply the telescope, as invented by Galileo in 1609, and the first employed for the purpose of exploring the heavens. A section of the instrument is represented in the annexed figure. It consists of an



object-glass A B, the focal length of which is usually from four to eight inches. The eye-glass, C D, is a double concave or plano-concave lens, from half an inch to two inches focus; the distance between the two lenses is equal to the difference of their focal lengths; and the magnifying power is in the ratio of those lengths. Rays of light, R R, falling on the object-glass, are refracted towards the axis X Y, and proceed to meet in the focus of the lens at F. But before they reach that point they are intercepted by the concave lens C D, the focus of which is also at F, and by which they are restored to their parallelism, or are even rendered divergent. The rays, therefore, proceeding from the object enter the eye, which is applied to the lens C D, without crossing each other, or forming an image; and hence the distinctness of the Galilean exceeds that of all other telescopes; hence, also, there is no inversion of the image, and, as there are only two glasses, the loss of light is inconsiderable.

The lens A B may be either single or compound. If a single lens of plate glass is used, it should be nearly convexo-plane; if a convex of plate and a concave of flint be combined to form the compound lens, the former should be nearly convexo-plane, and the latter concavo-plane. As to the eye-glass, it is always single; and the plano-concave form is perhaps better than the double concave, the eye being, in fact, never placed in actual contact with it. For any magnifying power above three or four, it ought to be limited to an aperture rather less than that of the pupil of the eye; and where distinct vision is desired, the eye should be placed as accurately as possible on the axis of the instrument. (Coddington's *Optics*.)

The area or field of view of this instrument is very limited, and for this reason it cannot be used with any high magnifying power. [TELESCOPE.]

Operameter. A piece of machinery for registering the number of revolutions made by the shafts or wheels of mill-work.

Operations, Calculus of. The name now given to 'the science which treats of the combinations of symbols of operation conformably to certain given laws, and of the relations by which these symbols are connected with the subjects on which they operate.' A striking *formal* analogy between certain results in the differential calculus and other purely algebraical ones having been observed, mathematicians were led to investigate its origin, and to perceive that it proceeded, not from accident, but from a true resemblance between the *operative laws* which were therein involved. It was thus that Arbogast and Servois (*Annales de Mathématiques*, vol. v.) were led to the principle of the separation of symbols of operation from those of quantity, and thence arose the far more general calculus of operations, by means of which we are not only enabled to arrive at known results with greater certainty and facility, and to express these results with greater brevity and elegance, but are also provided with a powerful instrument of investigation.

Several applications of the calculus to the processes of differentiation and integration having been already explained, we propose here merely to direct attention to the three operative laws which are most frequently contemplated, and afterwards to refer to the works in which the subject is treated from a more general point of view.

1. Two operations are said to obey the *law of commutation* when the result of their successive performance upon any subject is unaffected by the order in which the operations are applied. The *commutative* character of the symbols, ϕ and ψ, of two such operations is expressed by the equation

$$\phi\psi.u = \psi\phi.u,$$

where u is the subject operated upon. 2. An operation is said to fulfil the *law of distribution*, and the corresponding symbol ϕ is said to be

distributive, when, u and v being distinct subjects,

$$\phi(u+v)=\phi.u+\phi.v.$$

3. The *law of repetition* is expressed by the equation

$$\phi^m.\phi^n u=\phi^{m+n} u,$$

and is satisfied by all known operations; it merely indicates that the subject u is converted, by the operation ϕ, into another subject $\phi.u$, upon which the same operation may be repeated, and further that $\phi^3.u$, for instance, is to be regarded as an abbreviation for $\phi.\phi.\phi.u$. Assuming the generality of this *index law*, we are led to regard ϕ^0 as a non-operator and ϕ^{-1} as a symbol for the *inverse operation* which, performed upon the result of the direct operation ϕ, restores the original subject.

The only elementary *Treatise on the Calculus of Operations* yet published is by Carmichael (London 1855); a brief exposition of its principles, however, will be found in Gregory's *Examples* (Cambridge 1856), in Boole's *Differential Equations*, in Price's *Infinitesimal Calculus*, and in several other text-books. The more profound investigations on the subject by Boole, Hargreave, Bronwin, Graves, Cayley, Sylvester, Donkin, Spottiswoode, and others, will be found in the pages of the *Cambridge and Dublin Mathematical Journal*, and of the *Philosophical Transactions of the Royal Society and Royal Irish Academy*. Professor Boole's very able memoir 'On a General Method of Analysis,' *Phil. Trans.* 1844, may be said to have marked an epoch in the history of the Calculus.

Operculum (Lat. operio, *I cover*). In Botany, the lid of anything. The term is applied to the cap of the pitcher of *Nepenthes*; to the loose apex of such fruits as that of *Lecythis*; to the conical limb of the calyx of *Eucalyptus*, and to the body which closes up the spore-case of a moss.

OPERCULUM. In Zoology, this term is applied to the apparatus supported by four bones which protects the gills of fishes; also to the horny or calcareous plate which closes the aperture of univalve shells; and to the four calcareous pieces which defend the entrance to the tube of *Balanites* or bell-barnacles.

Ophicleide (Gr. ὄφις, *a serpent*, and κλεὶς, *a key*). The largest brass wind instrument of the trumpet species, and forming the bass to that class of instruments: its compass is from double B♭ to A♭ above the line, in the bass clef, being three octaves.

Ophidians (Gr. ὄφις). The name of the order of reptiles which includes all the serpentiform species of that class, corresponding to the *Amphibia serpentes* of Linnæus.

Ophioglossaceæ (Ophioglossum, one of the genera). A natural order of Ferns or pseudo-ferns, distinguished by the absence of a ring to the spore-cases, and by the straight, not circinate, vernation of the fronds. It is represented in this country by the Adder's-tongue, *Ophioglossum vulgatum*, and the Moonwort, *Botrychium Lunaria*.

Ophiomancy (Gr. ὄφις, and μαντεία, *prophecy*). The art of divination from serpents. Thus the seven coils of the serpent seen on the tomb of Anchises were held to indicate the number of years of Æneas's future wanderings:—

Septem etenim gyros, septena volumina traxit.

Ophiorhiza (Gr. ὄφις, and ῥίζα, *a root*). A genus of the *Cinchona* family, deriving its name of Snake-root from the circumstance that the roots of some of its species are reputed to be a cure for snake-bites. *O. Mungos* is thus regarded in Ceylon and India, and being intensely bitter may possess medicinal virtues; though in the case of snake-bites it often occurs that the reputation is based more on the snake-like form of some part of the plant—in this case the root—than on its curative properties. The same plant which grows in the Eastern and the Malay Archipelago is called *earth-gall* by the Malays on account of its bitterness.

Ophite (Gr. ὄφις). A synonym for Serpentine, in consequence of its spotted appearance, like the skin of a snake. The name is, also, sometimes applied to green speckled porphyry.

Ophites (Gr. ὄφις). The name of an early sect of Christian heretics, who emanated from the Gnostics, so called from their worshipping the serpent that tempted Eve. They considered the serpent as the father of all the sciences, which, but for the temptation of our first parents, would never have been known.

Ophiuchus (Gr. ὀφιοῦχος, *holding a serpent*), also called **Serpentarius.** One of the constellations of the northern hemisphere.

Ophrys (Gr. ὀφρύς, *an eyebrow*). A genus of terrestrial herbaceous tuberous-rooted Orchids, very nearly related to *Orchis*, and yielding some very pretty native species, occurring in dry pastures in the south-eastern parts of England. They have a curiously marked convex lip, which bears a resemblance to some insect, and from this circumstance the plants are called *Bee-orchis*, *Fly-orchis*, *Spider-orchis*, &c.

Ophthalmia or **Ophthalmitis** (Gr. ὀφθαλμία). Inflammation of the eye. This term is applied to diseased action of various parts of the eye. In common cases its seat is the conjunctival membrane, and it is relieved by fomentations of warm water or of decoction of poppy-heads, by leeches, cupping, purging; and, in violent cases, these depletive measures are by some practitioners carried to a considerable extent, and aided by blisters to the temple or nape of the neck. Emetics have sometimes been of service. When all inflammatory symptoms have subsided, local astringents and mild strengthening eye-waters may be resorted to; but so long as any inflammation remains, they should be most cautiously applied. Sometimes the iris is the seat of inflammation. This in some forms is attended with fever, great intolerance of light, and pain, and requires active treatment.

Inflammation may begin in the deep tissues of the eye, or, commencing from without, may extend to the internal structures, and the eye may be destroyed with great rapidity, or the transparent cornea may lose clearness, and the sight thus be lost. That dreadful scourge the Egyptian ophthalmia is of the latter character. The term *ophthalmia* must be regarded as a generic one, and we find its species or varieties very numerous. It may be of gouty, rheumatic, gonorrhœal or syphilitic character, and the treatment must be modified accordingly. The purulent ophthalmia of children, generally resulting from the existence of gonorrhœal or other irritating discharge in the mother, is frequently met with. It generally yields to mild astringent injections and gentle aperients.

Ophthalmodynia (Gr. ὀφθαλμός, *the eye*; ὀδύνη, *pain*). A violent pain in the eye without apparent inflammation; it is sometimes of a gouty character.

Ophthalmoptosis (Gr. ὀφθαλμός; πτῶσις, *a fall*). A protrusion of the whole globe of the eye.

Ophthalmoscope. An optical instrument, invented by Helmholtz in 1851, for the examination of the interior of the living eye. The parts of the eye behind the iris even when illuminated are not visible by ordinary means, because the light on emergence from the eye is returned in the direction of the source. There are now no less than thirty-seven forms of ophthalmoscope: two of them are adapted for self-observation, and are called autophthalmoscopes. The most usual arrangement is the following, which forms a simple pocket instrument. The light from a candle placed near the patient's ear is reflected by means of a small concave mirror into the eye. The interior thus illuminated is visible through a small perforation in the centre of the mirror, and can be magnified by the interposition of one or more lenses. This instrument can be rendered binocular by the employment of reflecting prisms. The ophthalmoscope is now extensively employed in the observation and treatment of diseases of the eye, and has even rendered service in cases of obscure brain disease. Photographs of the living retina can be successfully taken by means of this instrument.

Opianic Acid. A crystallisable acid formed by the action of peroxide of manganese on a solution of narcotine in dilute sulphuric acid. Its formula appears to be $C_{20}H_9O_9 + HO$.

Opianine. An alkaloid existing in Egyptian opium. Its properties resemble those of narcotine.

Opiate (Gr. ὀπός, *juice*). A medicine producing sleep. [ANODYNE.]

Opisthocœlian (Gr. ὄπισθε, *behind*, and κοῖλος, *concave*). A family of extinct *Crocodilia* in which the vertebræ presented the ball forming the articular surface in front, and the cavity to receive it behind. The fossil *Cetiosauria* and *Streptospondyli* form examples of this family. [PROCŒLIAN; AMPHICŒLIAN.]

Opisthodomus (Gr. ὀπισθόδομος). In Ancient Architecture, the enclosed space at the back of the cell of a Grecian temple, which corresponded with the Latin term *posticum*, and served generally as a treasure chamber.

Opisthographum (Gr. ὀπισθόγραφος, *written on the back*). In Classical Antiquity, a set of tickets, or a roll of parchment or paper, answering the purpose of a memorandum book or commonplace book, to enter notes for subsequent revision; so called from being written over both on the front and back. Any ordinary MS. in which the transcriber had employed both the front and back of the papyrus was indeed an opisthograph, strictly so called; a practice to which allusion is made in the well-known verse of Juvenal:—

Scriptus et in tergo, nec dum finitus Orestes.

Opisthotonos (Gr. from ὄπισθε, *backwards*, and τείνω, *I stretch*). A spasmodic action of the muscles, by which the body is bent backwards

Opium (Gr. ὀπός, *juice*). The inspissated juice of the poppy, obtained by wounding the unripe seed capsules of the *Papaver somniferum*, collecting the milky juice which exudes and dries in the sun, and kneading it into cakes. The cakes of the best opium are covered externally with pieces of dried leaves and the seed capsules of some species of *Rumex*. It should be of a rich brown colour, tough consistency, and smooth uniform texture; its peculiar narcotic smell should be strong and fresh; its taste bitter, warm, and somewhat acrid. The chemical analysis of opium has shown that its activity as a medicine principally depends upon the presence of a peculiar alkaline base called *morphia*, in combination with an acid which has been termed *meconic acid.* Opium also contains CODEIA, THEBAIA, NARCEIA, NARCOTINE, MECONINE, a volatile odorous principle, gum resin, extractive matter, and small portions of other substances.

The average relative proportions of the most important components of fine Turkey opium, previously dried, are given as follows, upon the authority of Messrs. T. and H. Smith, of Edinburgh, *Pharm. Journ.* October 1865:—

Morphia	10·00
Narcotine	6·00
Thebaine	0·15
Papaverine	1·00
Meconine	0·01
Meconic acid	4·00
Thebolactic acid	1·25
Codeia	0·30
Narceia	0·02
	22·73
Other matters	77·27

Opium is the most important remedy in the *Materia Medica*; for almost all other medicines, substitutes may be found, but for opium none, at least in the majority of cases in which its peculiar influences are required.

The English druggist gets his supplies of

opium chiefly from Asia Minor, and particularly from Anatolia, the shipments being made from Smyrna. Egyptian opium is seldom found in the European market, and still more rarely Persian opium. In wounding the capsules, care is taken not to cut through them; for in this case the seeds would not ripen, and poppy seeds are valuable for various economical purposes. The opium poppy may be, and indeed has been, cultivated in Southern Europe, but the climate is too uncertain for any reliance on a remunerative crop. It is said, too, that the poppy exhausts the soil more than most other plants, an opinion as old as the time of Virgil (*Geor.* i. 78). The ancients were well acquainted with the properties of the poppy, its medicinal effects having been noticed by so early an author as Hippocrates.

The market value of opium is determined on analysis by the quantity of morphia which it is found to contain. In the best specimens of dry Turkey opium, this is often as much as eight per cent., and it has been discovered in still greater quantity in some samples. The amount of opium imported into England in the year 1863 was 247,111 pounds from Turkey, 4,632 pounds from Egypt, and 2,571 pounds from other places. Turkey opium was worth 18*s.* 6*d.* a pound, Egyptian 9*s.* 10*d.*, and the rest 8*s.*, so that the total value of the imports was 232,145*l.* But, on the other hand, 110,101 pounds were exported, of which the largest amounts were taken by the United States, Holland, and New Granada. Up to 1828, a duty of 9*s.* a pound was levied on opium, but it was reduced to 4*s.* in that year, to 1*s.* in 1836, and the duty was totally abolished in the last revision of the tariff.

Opium has been for some time and is increasingly used as a means of intoxication in Turkey and India, and it is said that its consumption for these purposes has been greatly enlarged in this country. But the chief market for opium is China, where the habit of smoking it is very general, despite the prohibition and restrictions which the government has put upon its use. The drug which supplies the Chinese market is almost exclusively supplied from India, where the cultivation of the poppy is a strict government monopoly. Indian opium is not common in the European markets.

There are several kinds of Indian opium. The best is that of Patna. This, however, is not exported, but is employed in dispensaries only. Its quality, as estimated by the test mentioned above, is as high as that of the best Turkey sorts. Much opium is also grown in Kandeish, more in the Malwah district, and some in the Himalayan chain. Any person may engage in the culture of opium at his own discretion, but the government is the sole purchaser. It has been said that the occupation is not a profitable one, and that were it not for the advances made by government, the cultivation could not be carried on. As, however, the increase in the growth of this article is enormous, the exports having risen in quantity from 52,000 chests in 1850, to 82,216 chests in 1863, and the value from 6,000,000*l.* to 12,500,000*l.*, the statement may be doubted.

The form in which opium is imported into China is that known by the name of *investment.* It is made into cakes or balls, each of about four pounds weight. This opium, which contains about thirty per cent. of water, holds only two and a half per cent. of morphia. It is said that the chest of opium contains 159½ pounds. If so, the declared value of the exported commodity is about the same as that of the best Turkey opium in England, though probably the distance of the European market renders it possible to maintain such a monopoly price.

The introduction of opium into China was a legitimate branch of traffic down to the close of the last century. Ever since that period, however, the trade has been contraband; but though the Chinese government has issued edict upon edict prohibiting the importation of the drug, the consumption of Indian opium in China has in little more than sixty years risen from 1,000 to about 80,000 chests per annum. At first the trade was carried on at Whampoa, fifteen miles below Canton; and next at Macao, whence it was driven by the exactions of the Portuguese; the principal entrepôt being, till the outbreak of hostilities between the British and Chinese in 1840, in the bay of Lintin. The opium is kept on board ships, commonly called *receiving ships*, of which there are often ten or twelve lying together at anchor. The sales are mostly effected by the English and American agents in Canton, who give orders for the delivery of the opium; which, on the order being produced, is handed over to the Chinese smuggler, who comes alongside at night to receive it. Frequently, however, the smuggler purchases the opium on his own account, paying for it on the spot in silver, it being a rule of the trade, never violated, that the money must be paid before the opium is delivered. When the drug is landed, the laws are equally set at defiance in its progress through the country, smoking houses being, it is said, everywhere established.

One of the latest travellers in China, Dr. C. A. Gordon, states that the home cultivation of opium is commenced in the Shensi province; and that, although the quality is inferior, it is probable that in course of time its superior cheapness will prove a formidable rival to the monopoly of the East India government. The officials have, no doubt, connived at the trade—have been, perhaps (without being, as has been stated, corrupt), disposed to wink at so universal a practice as that of opium smoking, and have been also probably, to some extent, addicted secretly to the habit themselves.

When the habit is indulged in to excess (and it rarely happens that self-control is compatible with even a scanty indulgence), the most serious physical, moral, and intellectual consequences ensue. Some of the effects of opium eating (opium smoking appears to be even more dele-

terious) are described in De Quincey's essays. The last days of Coleridge's life were wasted in the alternate excitement and depression induced by this stimulant. With the duller Oriental, the effects are far more degrading; and all travellers in China concur in acknowledging the miserable results of indulgence in the practice of opium smoking. It may be impossible, perhaps, for government to interfere with private enterprise, and to check the trade in a commodity which another government strives, ineffectually perhaps, but with right motives, to keep out of its dominions; but that a government should sanction such a traffic, and that it should even force it upon the community, by making war on the administration which strives to prevent the importation of so noxious a drug, is perhaps as discreditable as it seems to be exceptional. At present, however, the taste for opium smoking is fixed, and is spreading in China, and no means will in all likelihood be effectual to prevent the extension of the practice.

Opobalsam (Gr. ὀποβάλσαμον). Balsam or balm of Gilead, an oleo-resin of a peculiar fragrancy, which exudes from *Balsamodendron gileadense*.

Opochala. An oil-yielding plant of Western Africa, the *Pentaclethra Macrophylla* of botanists.

Opodeldoc. A term invented and formerly applied by Paracelsus to a plaster for all external injuries; but in modern usage it signifies a liniment made by dissolving soap in alcohol, with the addition of camphor and volatile oils.

Opoïdia. The name of a genus of Umbelliferous plants, which at one time was supposed to yield the fetid gum resin called *galbanum*, but this appears to have been a misapprehension. The plant is a tall stout herb, found wild in Persia.

Opopanax (Gr.). A gum resin having a peculiar and rather disagreeable odour, formerly used in medicine. It is the produce of the *Opopanax Chironium*, and is brought from the Levant.

Opossum. The common name of the Marsupial quadrupeds of the genus *Didelphys*, characterised by three kinds of teeth, viz. incisors, canines, and molars; by hinder hands, and a prehensile tail. With this organisation the opossums, as might be expected, are arboreal in their habits, and feed on a mixed diet, in which animal food preponderates. The larger species have a well-developed abdominal pouch, in which the young are received at a singularly early stage of developement. In some of the smaller opossums the characteristic pouch is nearly rudimentary, and the young are carried by the parent on the back, where they cling to the fur, and likewise hold on by entwining their little prehensile tails round that of the mother: the name *Didelphys dorsigera* is on this account given to one of the species. The true opossums are now limited to the American continent; but during the Eocene period there were species of *Didelphys* in both France and England. [MARSUPIALIA.]

Opposition (Lat. oppositio). In Astronomy, this term denotes the aspect of two bodies when diametrically opposite to each other. Thus the moon, or a planet, is said to be in opposition with the sun when it passes the meridian at midnight.

OPPOSITION. In the Fine Arts, CONTRAST [which see].

Ops (Lat. akin to opimus, *wealthy*). In Mythology, a Latin goddess of plenty and fertility, who was supposed to have her abode in the earth, and was regarded as the wife of SATURN.

Opsiometer (Gr. ὄψις, *sight*, and μέτρον, *measure*). An instrument for measuring the extent of the limits of distinct vision in different individuals, and consequently for determining the focal lengths of lenses necessary to correct imperfections of the eye. A contrivance for this purpose, by M. Lehot, is described in the *Annales des Sciences d'Observation* for June 1829, and in the Notes by M. Quetelet to the French translation of Herschel's *Treatise on Light*. Its principle depends on the appearance presented by a straight line placed very near the eye, in the direction of its axis; and it is carried into practice by placing a thread of white silk on a narrow rule covered with black velvet and furnished with a suitable apparatus for marking the exact points at which the thread begins and ceases to be distinctly seen, when held in a certain position with respect to the eye. An instrument for the same purpose, on a different principle, had formerly been suggested by Dr. Young.

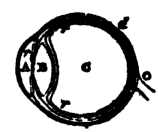
Optative Mood. [GRAMMAR.]

Optic Nerves. The second pair of nerves. They arise from the *thalami nervorum opticorum*, and, perforating the bulb of the eye, form the *retina*.

Optics (Gr. ὀπτικός, *belonging to sight*). That branch of physical science which treats of light and vision.

The theory of light, and the different hypotheses respecting its propagation, having been explained under the term LIGHT, and its most remarkable properties being described under their respective heads [CHROMATICS; DIFFRACTION; INTERFERENCE; POLARISATION; REFLEXION; REFRACTION, &c.], we shall here confine ourselves to the explanation of the phenomena and laws of vision, and the formation of images; and this, in fact, comprehends all that is meant by *optics*, in the strict sense of the word.

Description of the Eye.—The human eye is of a spherical form, having a slight projection in front. The annexed figure represents a horizontal section of it through its axis. It consists of three principal chambers, filled with different *humours*, or transparent media of different refractive powers. The first of these media, occupying the



anterior chamber A, is called the *aqueous* humour, and consists almost entirely of pure water. The cell in which the aqueous humour is contained is bounded on its anterior side by a strong horny transparent substance, called the *cornea*, the figure of which is an ellipsis of revolution about its major axis. The posterior side of the cell is formed by the *iris*, a kind of circular opaque screen consisting of muscular fibres, by the contraction or expansion of which an aperture in its centre, called the *pupil*, is increased or diminished according to the illumination, in order to protect the eye and preserve its sensibility by equalising the quantity of light admitted into it. The second humour, called the *crystalline lens*, B, enclosed in its capsule, lies immediately behind the pupil. Its figure is a solid of revolution, having its anterior surface much less curved than the posterior; and both surfaces are ellipsoids of revolution about their lesser axes. The crystalline is somewhat denser towards the centre than at the outside; the increase of density serving to correct the aberration, by shortening the focus of the rays near the centre. The third or *vitreous* humour, C, fills the posterior chamber of the eye. This fluid scarcely differs from the aqueous humour, either in specific gravity, or chemical composition, or refractive power.

The following are the refractive powers of the different humours of the eye, according to Sir David Brewster, the ray of light being incident on them from air:—

Aqueous Humour	Crystalline Lens Surface	Crystalline Lens Centre	Crystalline Lens Mean	Vitreous Humour
1·336	1·3767	1·3990	1·3879	1·3394

But as the rays refracted by the aqueous humour pass into the crystalline, and from the crystalline into the vitreous humour, the indices of refraction of the separating surfaces of these humours will be—

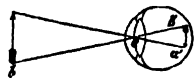
From aqueous humour to outer coat of crystalline	1·0466
From ditto to crystalline, using the mean index .	1·0353
From vitreous to crystalline outer coat . .	1·0445
From ditto to ditto, using the mean index .	1·0332

('Optics,' *Cabinet Cyclopædia.*)

The posterior surface of the cell of the vitreous humour is covered by the *retina*, *d*, a network of inconceivably delicate nerves, all branching from the *optic nerve*, O, which enters the eye obliquely at the inner side of the orbit next the nose. The retina lines the whole of the cavity C from *r* to *r*, at which point the capsule of the crystalline commences. Its nerves are immersed in the *pigmentum nigrum*, very black velvety matter which covers the choroid membrane, and the use of which is to absorb and stifle all the light which enters the eye as soon as it has done its office of exciting the retina; thus preventing internal reflections, and consequent confusion of vision. The whole of these humours and membranes are contained in a thick tough coat, called the *sclerotica*, which unites with the cornea and forms what is commonly called the *white of the eye*. The spot at which the optic nerve, O, enters the eye is totally insensible to the stimulus of light, and is therefore called the *punctum cæcum*. (Herschel on Light, *Ency. Metr.*) For a more detailed and anatomical description of the eye, see Eye.

From this description of the eye it is evident that light in passing through it must undergo a series of refractions, in the same manner as in passing through a system of lenses. When a pencil of luminous rays, proceeding from an exterior point, passes through the transparent cornea and penetrates the aqueous humour, the divergence of the rays is diminished by this first refraction. The rays which pass through the pupil undergo a second refraction at the anterior surface of the crystalline, which renders them still more convergent; and on leaving the crystalline and passing into the vitreous humour they acquire their final degree of convergence, and proceed to form an image at a focus on the retina, or very near that membrane. Experience and calculation prove that when vision takes place with the least effort, the luminous point (or any very small object on which the eye is fixed) is at such a distance from the eye that the rays enter the eye with precisely that degree of divergence which is required, in order that after suffering the several refractions they may be brought to meet in a point on the retina itself. Hence it has been concluded that the sensation of sight is caused by the impression made by light on the retina, when it is concentrated on it in a single point or within a very small space.

The image of an object on the retina is evidently inverted with respect to the position of the object itself; for the ray proceeding from the upper extremity of an object, *a*, falls on the lower extremity *a′* of the image on the retina.



Writers on optics have often puzzled themselves with attempts to explain the cause of erect vision from an inverted image; the subject, however, is a purely psychological one, and does not admit of a physical explanation.

Another circumstance, the cause of which has also been much discussed, is, that although an image of each object at which we look is formed on the retina of both eyes, the object appears single. Single vision with two eyes is attributed by Dr. Smith to the habit of referring the two impressions made on corresponding points of the two retinas to the same object; and in fact, if we press slightly on the cornea of one eye so as to derange its optical axis, the two images, being no longer on parts of the retina which habitually correspond, will appear double. Those who have had one eye distorted by a blow see double, till habit has taught them anew to see single, though the distortion remains. (For a review of the various theories that have been proposed to account for this phenomenon, the reader may be referred to a paper on the Physiology of Vision, by Professor Wheatstone, in the *Phil. Trans.* for 1838.)

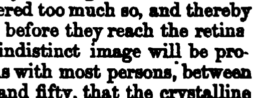
As the judgment which we form of the real magnitude of a distant object depends not only on the apparent magnitude, but also on our estimation of its distance, an erroneous estimate of the distance will necessarily produce an illusion with respect to the magnitude. Such illusions are frequent in the night time, when the darkness prevents us from distinguishing the real places of objects and their relative positions. An unusual increase or deficiency of the transparency of the atmosphere produces the same effect; and at sea, where little assistance can be derived from the appearance of intervening objects, it requires a particular training of the eye to judge correctly of distances.

The effect of light on the eye has a sensible duration after the eye is shut, or the luminous object removed. During the twinkling of the eye, we never lose sight of the object on which we are looking; and if a burning stick be attached to the extremity of a string, and whirled rapidly round, a complete circle of light appears. This *persistence* of light on the retina gives rise to a great number of illusions; such as the apparent augmentation of volume of a musical chord when in rapid vibration, the train of light which appears to accompany falling meteors, &c. It was estimated by D'Arcy that the light of a live coal, whirled round at the distance of 165 feet, maintained its impression during the seventh part of a second. Experiments, however, of a more accurate kind have shown that this time is not constant, but is influenced by several circumstances. Light must act on the eye for some continuance of time in order to produce a complete impression; and it is found that the time during which the impression that has been produced can preserve an equal intensity after the action of light has ceased is greater in proportion as the impression is less intense. On the contrary, the whole duration of the impression is greater as the light is more intense. If the impression has been made by a strongly illuminated object, as the setting sun, it often passes through a series of different colours; in other circumstances, it disappears, and is renewed after some seconds; disappears again, and so on several times in succession.

The eye possesses considerable power of adjusting its parts so as to give distinct vision for all distances within certain limits. The first of these limits is the least distance from the eye at which small objects, as the print of a book, can be seen without effort; and the second, the distance at which the image of the object becomes confused. The space between these limits is the field of vision; but both its extent and distance from the eye vary considerably with respect to different individuals, and sometimes even with respect to the two eyes of the same individual. From the known dimensions of the eye, and the refractive powers of its different substances, it is found by calculation that the focal distances of two luminous points, situated at the two limits of the field of vision, differ by about one sixth part of the diameter of the eye.

All the refractions which take place in the interior of the eye are in the same direction; consequently the eye, regarded as an optical instrument, is not achromatic. The absence of colour about the images formed on the retina, excepting in very particular cases, is to be ascribed in part to the small breadth of the pencil of luminous rays which passes through the pupil, but principally to the small focal distance of the eye; in consequence of which the unequally refrangible rays can never be much separated from each other. It has also been surmised (Coddington's *Optics*) that a compensation takes place between the refractions at the cornea and the crystalline, a ray which is less refracted by the former being more refracted by the latter, in consequence of its passing through it at a greater distance from the axis.

Distinct vision depending on the convergence of the luminous rays which proceed from an object to a focus on the retina, it follows that if, from any defect in the original structure of the eye or any deterioration of its form or powers, the rays which enter the pupil are not rendered sufficiently convergent to meet at the retina, or are rendered too much so, and thereby brought to a focus before they reach the retina an imperfect and indistinct image will be produced. It happens with most persons, between the ages of thirty and fifty, that the crystalline lens begins to undergo a change, by which not only its form, but also its density and refractive power, are altered in such a manner as to leave it capable of affording distinct vision only of remote objects. This defect is remedied by a convex lens, which makes up for the flatness of the crystalline, and renders parallel rays slightly convergent before entering the eye. Let $a\ b$ be an object, c the lens, and e the centre of the eye, and suppose the object to be placed at the focal distance of the lens. Since the object is at the focus, the rays of a pencil diverging from any point a in it will emerge parallel to each other and to $a\ c$; they will, therefore, after refraction in the eye, be brought to converge on the retina at a point a' such that $e\ a'$ is parallel to $a\ c$. Similarly, rays from b, after refraction through the lens and the eye, will converge to the point b', such that $e\ b'$ is parallel to $b\ c$. Thus a distinct image $a'b'$ will be formed



on the retina, and the apparent angular magnitude of the object seen through the lens will be the angle $a'\ e\ b'$, which is equal to $a\ c\ b$, the angle subtended by the object at the centre of the lens, and therefore greater than the angle subtended by the object at e, the centre of the eye. Hence the image appears enlarged; but, the nearer the lens is to the eye, the less will be the difference between the apparent magnitudes of the image as seen with and without the lens. When such lenses are employed

in the form of spectacles, the enlargement of the image (which in this case is not intended) is hardly sensible, because the lens is commonly of low power, and because the person who must use it, to see distinctly, cannot easily make a comparison between the appearance of an object seen with or without the lens. The lenses of spectacles ought to be of the meniscus form [LENS], in order to refract, without inducing indistinctness, pencils coming to the eye with any degree of obliquity. Such spectacles are called *periscopic*, and their advantage was first pointed out by Dr. Wollaston.

Sometimes the eye is so formed that its power of giving convergence is too great, and the rays are brought to a focus before they reach the retina. Persons having this defect are called *shortsighted*, from their inability to see distant objects distinctly. It arises from an increase of density, in the centre part of the crystalline; and its inconvenience is obviated by a concave lens, which increases the divergence of the rays before they enter the eye. For the same reason as mentioned above, the lens should be of the convexo-concave form, i. e. convex on the outer side and concave on the inner side, the curvature of the latter being greater than that of the former. This lens diminishes the apparent magnitude of objects, but the effect is scarcely sensible. (ith's *Optics*; Herschel's 'Treatise on Light,' . *Metropolitana*; Brewster's 'Optics,' *Cab.* Coddington's *Optics*; Lamé, *Cours de e*; Fick, *Medicinische Physik.*) [LENS; MICROSCOPE; TELESCOPE; &c.]

Optical Parallax in Vision. The apparent displacement in position undergone by an object when viewed by either eye singly. The coalescence of the separate images produced by each eye into the single one, which we ordinarily perceive with both eyes, is generally explained by supposing that there are corresponding points in each retina which give to the mind exactly the same impression of position. When the eyes are so adjusted that the two images do not fall on corresponding points, objects appear double. This effect commonly occurs in a state of reverie, and can be readily produced by a slight pressure on one eye-ball.

Optimates (Lat.). A word sometimes used to denote the Roman nobility, in contradistinction to the plebeians, or populares.

Optimism. In Moral Philosophy and Theology, the system which regards physical and moral evil as elements of the universal order of things: so that everything is good, viewed in relation to the whole; or, in the ordinary phrase, that 'all is for the best.' This system was justified, with philosophical induc- Leibnitz in his THEODICÆA, and is illustrated by Pope, in his *Essay on Man*; but it is best known (as far as the name is concerned) by the irony of Voltaire, in his celebrated romance of *Candide*. The optimism of Leibnitz was based on the following trilemma: If this world be not the best possible, God must either, (1) not have known how to make a better, (2) not have been able, (3) not have chosen. The first position contradicts His omniscience, the second His omnipotence, the third His benevolence. (Creuzer; *Leibnitzii Doctrina de Mundo Optimo*, Lips. 1795.)

Optimus Maximus (Lat. *best* and *greatest*). Epithets assigned to Jupiter by the ancient Romans to indicate his superlative greatness and goodness.

Option (Lat. optio, *a choosing*). In Ecclesiastical Law, a prerogative of the archbishops of the church of England. Every bishop is bound, immediately after his confirmation, to make to the archbishop a legal conveyance of the next avoidance of any one benefice or dignity belonging to his see which the archbishop may choose (whence the name). If the archbishop dies before the avoidance happens, the right of filling it up passes to his executors or administrators as his private property.

OPTION. On the Stock Exchange, a percentage given for 'the option' of putting or calling, i.e. selling or buying, stock in time bargains at a certain price. For similar technicalities, see STOCK EXCHANGE.

Optometer. An instrument for measuring the focal distance of the eye, or the distance at which a minute object is distinctly seen. As the distance varies in respect of different individuals, the instrument is applicable to the purpose of determining the focal lengths of spectacles required for myopic or presbyopic eyes.

The principle upon which the optometer is constructed appears to have been first established experimentally by Scheiner, and subsequently by Dr. Motte of Dantzic, and by Dr. Porterfield. If we look at any minute object through two pin holes, or two parallel slits made in a card or any opaque thin body, the distance between the holes or slits being less than the diameter of the pupil of the eye, then, if the object be at the point of perfect vision, the image on the retina will be single, but in every other case it will be double; and, on varying the distance of the object from the eye, the two images will be seen to approach to or recede from each other. As a consequence of this, if the object looked at be a line pointed nearly towards the eye, it will appear as two lines, crossing each other in the point of perfect vision at a very acute angle.

The practical application of this principle is extremely simple. As proposed by Dr. Thomas Young, the optometer may be made of a slip of card paper, or ivory unpolished, about eight inches in length (this being the distance of distinct vision for most eyes), and one in breadth, divided longitudinally by a black line which must not be too strong. The end of the card is bent into a position nearly perpendicular to its length, or a detached piece may be applied in the same inclined position. In this part (which is applied to the eye) a hole of about half an inch square must be made, the side being so cut as to receive a slide of thick

paper, with slits of different sizes from a fortieth to a tenth of an inch in breadth, divided by spaces somewhat broader, so that each observer may choose that which best suits the aperture of his pupil. The slide is then brought close to the eye, and the black line viewed through two adjacent slits: it appears as two lines intersecting each other; the point of intersection is marked, and the distance of this point from the slide is the focal length of the eye. (Young's *Lectures on Natural Philosophy*, vol. ii. p. 576, or p. 354 of Kelland's edition; Priestley's *History of Discoveries relating to Vision, &c.* p. 641.)

Opuntia (so named from the country of the Opuntii). In Botany, the name given to those Cactaceous plants commonly called Indian Figs or Prickly Pears. Their stems consist of flat joints, broader at the upper than at the lower end, becoming, however, eventually both continuous and cylindrical. Their native country is South America; but in some places the lava of Mount Etna is covered with them, and the large purple juicy fruits which they yield find considerable sale in the Sicilian markets. The cochineal insect is fed on *Opuntia cochenillifera* and *O. Tuna*.

Opus Incertum (Lat. *uncertain work*). The manner in which the ancient Romans executed their irregular masonry, so far as regards the conditions of bond. The opus incertum was composed of small polygonal masses of stone set in mortar, and occasionally traversed by beds of bricks, or tiles, that served to form the bond, the angles of the buildings being also carried up in brick. The opus incertum differed from the opus reticulatum, inasmuch as the latter was composed of regular blocks, laid in the building so as to represent the meshes of a net; the bricks and tiles were introduced as bond courses, and as the angles (or coins) of the masonry in the case of the opus reticulatum, as they were in that of the opus incertum. The latter style was the more ancient one of the two, and it was more generally adopted. In many cases the brickwork at the angles, and in the bond courses, was replaced by squared stone work, or the opus quadratum, wherever local circumstances justified that style of construction.

Or (Fr. *gold*). In Engraving, it is represented by a white surface sprinkled with equidistant dots.

OR. In Heraldry, one of the metals employed in blazonry. It is equivalent to topaz among precious stones, and Sol among planets.

Ora (A.-Sax. *metal or money*). A money of account, frequently quoted in Anglo-Saxon charters and in Domesday Book, estimated at sixteen or twenty pence, as the greater or less ora. The word also occurs in Swedish and Danish records, not only as a quantity of money, but as a measure of land. (Ducange s.v.)

Orach or Orache. One of the old garden potherbs, now superseded by better esculents, especially spinach. It is the *Atriplex hortensis* of botanists.

Oracle (Lat. oraculum, from os, *a mouth*). The answer given by heathen deities to those who consulted them. The name was afterwards extended also to the places where such answers were given. The practice of consulting oracles was peculiarly Greek. In Italy we have nothing which answers exactly to the Greek oracle or χρηστήριον. The Roman sought for counsel not from the human mouthpiece of an unseen god, but from visible signs, whether in the heavens or on the earth. He was, in fact, under the sway of a priestly system which was worked for purely political ends. In Greece it is certain that these oracles exercised great influence down to a time not long preceding the Christian era; but on the nature and the source of that influence there is not the same agreement of opinion. The responses known to us are chiefly those which were given to kings, princes, statesmen or public persons in general; and there are reasons for doubting whether these give fair grounds for judging of their average character. If a few have regarded them as altogether an imposition, others have attributed to them a diabolical inspiration. The character of the answers will not admit of the latter supposition as a general explanation; in the former case they could never have retained that permanent hold on the people which undoubtedly they possessed. If the whole action of the oracles had been such as was exhibited in their corrupt or ambiguous responses, the faith reposed in them must have been an impossibility. The story of Glaucus, the son of Epikydes (Herodotus vi. 86) and the parable which saved the life of Pactyas (Herodotus i. 159) show that they were consulted in cases of moral difficulty; and the inference seems fair that they were consulted far more frequently for such reasons than for any other. On this hypothesis their influence was primarily a moral one—an influence lawfully and righteously acquired, though it may have been unrighteously and corruptly exercised; and when their authority began to decay, we may well believe with Dr. Arnold (*Later Roman Commonwealth*, vol. ii. p. 397) that in the general immorality which increased as the faith in the old mythology grew weaker, the change was greatly for the worse, and that, whatever may be the falsehood of their oracular predictions, 'there are yet specimens of their moral doctrine preserved, which exhibit a purity and wisdom scarcely to be surpassed.'

Apart from these instances of genuine moral teaching, all other answers may be ranged under the following heads: 1. Enigmatical answers. To this class belong the tale of the discovery of the bones of Orestes (Herodotus i. 67), the story of the Corinthian Cypselus, and of the defeat of the Spartans by the men of Tegea (Herodotus v. 92, i. 66). All these may be set down as the mythical form under which alone the popular mind could conceive and retain the traditionary history. 2. Ambiguous

answers, forming much larger class, of which instances are found — the story of Pisistratus (Herodotus i. 62), of the fall of Crœsus (ibid. i. 53), and of the Roman emperor Maxentius. (Gibbon's *Roman Empire*, ch. xiv.) 3. Answers dictated by a calculation of probabilities. Such are the prohibition given to the Cnidians (Herodotus i. 174) and the oracles relative to the colonising of Cyrene (Herodotus iv. 154, 157). These answers were often, perhaps generally, mistaken. Of all the oracles consulted by him, Crœsus is said to have found two only which spoke truly (Herodotus i. 49). 4. Answers extorted by political and personal influence. By such influence the Alcmæonidæ are said to have brought about the overthrow of the Pisistratidæ; and by it also Demaratus was driven from the throne of Sparta. (Herodotus v. 63, vi. 66.) 5. Predictions made up after the event. Such are those which relate to the death of Leonidas at Thermopylæ, and still more those which are said to have been given to Crœsus, and which, in the judgment of Sir G. C. Lewis, 'bear for the most part indubitable marks of subsequent fabrication.' (Lewis, *Credibility of Early Roman History*, vol. ii. p. 525; Rawlinson, *Herodotus*, vol. i. pp. 92, 188 &c.; Cox, *Tale of the Persian War*, part ii. ch. iv.; M'Culloch, *Geog. Dict.* art. 'Delphi;' Clavier, *Mém. sur les Oracles des Anciens*, 1819 &c.)

The general influence of the oracles was undoubtedly on the decline before the introduction of Christianity; but the rise of the latter was not the sole cause of this loss of power. Plutarch mentions that in his time the oracles were consulted only on private questions and for the interests of individuals; and there can be little doubt that the decay and extinction of Hellenic freedom and nationality sealed the doom of the Hellenic oracles.

Herodotus ascribes the founding of the great oracle of Zeus (Jupiter) at Dodona to a prophetess brought from Egypt by Phœnician traders. But his account is a mere rationalising of the tale told to him at Dodona; and the idea of Egyptian influence here has no better historical foundation than that which traces the art and philosophy of Greece to the same source. (Sir G. C. Lewis, *Astronomy of the Ancients*.)

Oral (Lat. os, oris, *a mouth*). In Zoology, this term is applied to the various parts which form or relate to the mouth of animals.

Oral Tradition. [Historical Credibility.]

Orang. In the Malay language, this word signifies man; orang-utan is therefore the man of the woods. By this term we commonly designate the Indian or red orang (*Simia satyrus*, Linn.). This species inhabits the great islands of Borneo and Sumatra, and attains the height of from four to five feet, measured in a straight line from the vertex to the heel. It has neither tail, cheek-pouches, nor ischial callosities; but has an appendix to the cæcum coli, as in man. It wants the ligament of the hip joint, and acquires an enormous laryngeal pouch when full grown. [Chimpanzee.]

Orange (Ital. arancio, Venetian naranza, Span. naranja: according to Mr. Wedgwood, the name was introduced with the fruit, the Arabic word being nâranj: *Dictionary of English Etymology*). The well-known fruit of the Orange-tree, the *Citrus Aurantium* of botanists. India and China are the native countries of the orange; and the Portuguese are entitled to the honour of having transferred the plant to other countries. Oranges are not considered to have been grown in Europe till the fourteenth century; and in England they have been cultivated in conservatories since 1492. They are propagated either by seeds, by cuttings, by layers, by grafting, or by inarching; but the plants grown from seeds require so long to come to perfection that they are seldom so propagated in England. Oranges are imported into this country in chests and in boxes, packed separately in paper. The best are brought from the Azores and Spain; but very good ones also come from Portugal, Italy, Malta, and other places. The orange trade carried on by this country is of great value and importance. Not only is the fruit held in high estimation, but, from the extreme productiveness of the tree, it is sold at a price little more and sometimes even less expensive than our ordinary domestic fruits. The quantity of oranges and lemons imported in 1863 amounted to 1,346,585 bhls., at a computed value of about 758,000*l.* The imports in 1864 were somewhat less.

The peel of the orange when preserved is a well-known article of confectionery; its flowers yield an essential oil (neroli) scarcely less esteemed as a perfume than the celebrated attar of roses: while, as if nature had intended every part of it for the use of man, the wood of the tree is susceptible of the highest polish, and is extensively employed in the arts.

The principal species of the Orange family are the Orange, the Lime, the Lemon, and the Citron. The sweet orange of commerce is the produce of different varieties of *Citrus Aurantium*, and is one of the most grateful of fruits. The Seville Orange is the fruit of *Citrus Bigaradia*. [Citrus.]

Of other plants bearing the name of Orange, we may mention the Mock Orange, a garden name for the shrub *Philadelphus*; the Osage Orange, which is *Maclura aurantiaca*; and the Quito Orange, which is the berry of *Solanum quitoënse*.

The given to the society instituted in Ireland in 1795 to uphold the Protestant religion and ascendency, and for the discouragement of Catholicism. It had office-bearers, a secret organisation, distinctive or orange colours, and occasional processions.

Orangery. A kind of gallery, in a garden or parterre, for preserving orange-trees during the winter season. An orangery is distinguished from a conservatory by its having an opaque roof, while that of the latter is glazed.

That at Versailles is one of the most magnificent ever built. For trees in large boxes a proportionably large and lofty house is requisite; it may be opaque on the north side and roof, with a glass front, of any convenient or desired length, width, and height. For one of moderate size, the height at the back wall may be fifteen feet, at front ten feet, and the width of the house fifteen feet. The floor may be either perfectly level, and the boxes placed on it, the largest behind, so that their tops may form a slope to the front glass, as in the conservatory of Prince Borghese at Rome; or if the trees are young, a stage may be erected for a few years, in order to raise the plants to the light. If, however, the trees are of a considerable size, a good plan is to have square pits in the floor at regular distances, somewhat larger than each box, and in these to sink the boxes, covering them with mould, sand, or moss, nearly to the level of the pavement, so that each tree so placed and dressed will appear as if planted in a small compartment of earth. Such is the plan of the large conservatory in the royal gardens at Monza. The walk, unless where a stage is adopted, should be in the middle of the house, with corresponding doors in each end; but where the trees are young, and placed on a stage like greenhouse plants, the walk should be in front, as in no other situation could the eye of the spectator meet the foliage of the plants. Where the walk is in the middle, with a double row of trees on each side, as at Monza, the effect in winter is magnificent.

Where the trees are to be planted as standards in the borders or floor of the house, it is requisite for the health and beauty of the plants that the building be glazed on all sides, and heated by hot water or flues. In winter the beds might be covered with turf, strewed with daisies, violets, and primroses; these would come early into flower, and if the turf were kept very short about the roots of the flowering plants, and the trees in excellent condition, only those who have seen the first-rate regularly planted standard orange groves of Nervi could form an idea of the effect, which, by contrast with the external winter, would be felt as an anticipation of real spring.

Orangite. A name given to the orange-coloured varieties of Thorite from Brevig in Norway.

Oratorio (Ital.). A sacred musical composition consisting of airs, recitatives, duets, trios, choruses, &c., the subject of which is generally taken from Scripture. The text is usually in a dramatic form, as in Handel's *Samson*; but it sometimes takes the form of a narrative, as in *Israel in Egypt*; occasionally it is of a mixed character, as in Haydn's *Creation*; and sometimes it consists merely of detached passages from Scripture, as in the *Messiah*. The origin of oratorios has been variously accounted for; but the most prevalent opinion regards them as originally founded upon the spiritual songs and dialogues which were sung or recited by the priests of the oratory. [ORATORY.] The more recent introduction of this species of musical drama is on all sides attributed to St. Philip Neri, about the middle of the sixteenth century; but oratorios, properly so called, were not produced till about a century afterwards. At first the persons introduced were sometimes ideal, sometimes parabolical, and sometimes, as in the later oratorios, taken from sacred history; but this species of drama soon assumed a more regular form, and oratorios became great favourites in Italy, where they were constantly performed during the Carnival; and they have since given birth to some of the noblest and most elaborate compositions of the great masters both of Italy and of other countries. Oratorios were first introduced into England by Handel in 1720, though they were not publicly performed till 1732.

Oratory. A room in a private house set apart for prayer. It differs from a chapel, inasmuch as it does not contain an altar, nor may mass be celebrated in it.

ORATORY. In Rhetoric. [ELOQUENCE.]

Oratory, Priests of the. Various congregations of ecclesiastical persons living in community, without being bound by any special vow, have assumed this title. The first congregation of the Oratory was founded by St. Philip Neri, at Rome, in the beginning of the sixteenth century. Similar societies were soon formed in Italy and the Low Countries, but without any mutual connection; and such now exist in England, France, and elsewhere. The congregation of the Oratory at Paris was founded by the cardinal Pierre de Bérulle in 1611, and had several houses in different parts of the country. It produced many men of celebrity; among others, Malebranche and Massillon. There can be no doubt that its chief object was to counterbalance the increasing influence of the Jesuits.

Orb (Lat. orbis). In the language of the old astronomers, this word usually signifies a hollow sphere. They supposed the heavens to consist of such orbs or spheres, enclosing one another, and carrying with them in their revolutions the different planets. (Sir G. C. Lewis, *Astronomy of the Ancients*.) The *orbis maximus*, or great orb, was that in which the sun is placed. As the orbs were concentric, and their number equal to that of the known planets, with one for the moon and another for the fixed stars, it was necessary to suppose them to be transparent or crystalline. The word also denotes any round or circular body, and sometimes it is used synonymously with *orbit*.

ORB. In Heraldry, the globe (orbis terrarum), originally assumed by the Roman emperors of later times, as a type of universal sovereignty, and now among the common insignia of monarchical authority.

Orbiculata. A tribe of Brachyurous Crustaceans, including those which have an oblong ovoid carapace.

Orbiculus. In Botany, the whole mass of that part of a flower called the corona in the

genus *Stapelia*; also, a round flat hymenium contained within the peridium of some genera of fungi.

Orbit (Lat. orbita, *a wheel-track*). In Astronomy, the path which any celestial body describes by its proper motion. The orbits of all the planets and satellites are ellipses; and recent discoveries seem to show that the orbits of double stars, which revolve about each other, are curves of the same kind. Some comets have been supposed to move in parabolic or hyperbolic orbits. [PLANETS; MOON; SATELLITE; STAR.]

ORBIT. In Crustacea, that portion of the carapace in crabs and lobsters (*Decapoda*) to which the eye is attached, and the groove into which the eye and its peduncle are retracted. In sessile-eyed Crustacea there is no true orbit, the eyes being placed in the lateral or anterior portion of the head. In *Trilobites* and *Limuli* the cheeks bear the eyes upon their upper surface.

ORBIT. In Ornithology, this term is applied to the skin which surrounds the eye; this is generally bare of feathers, for the facility of its movements, but especially so in the parrot tribe and the heron.

ORBIT. In Osteology, the bony cavity in which the eyeball is embedded. Each orbit in man is formed by seven bones—the frontal, maxillary, jugal, lacrymal, ethmoid, palatine, and sphenoid. The number of orbital bones, and the portion and degree of circumscription of the orbit, vary much in lower vertebrates.

Orcein. The deep red colouring principle of the lichen pigments (archil, cudbear, litmus, &c.). It occurs naturally, to a small extent, but is chiefly derived from the decomposition of the acids in the lichens.

Orchard (Gr. ὄρχατος). An enclosure devoted to the culture of fruit-trees. The most productive orchards are generally such as are situated on declivities open to the south or south-east, and sheltered from the north, north-east, and west. The most suitable soil is a calcareous clayey loam with a dry subsoil. The climate of orchards so situated is always warmer than any other kind of situation which this country affords, and the subsoil is more certain of being dry. The surface of the soil, in the case of orchards so situated, is generally kept under pasture; which, while it prevents the earth from being wasted away by rains, is favourable to the running of the roots immediately under the surface, by which they are sooner called into action by heat in spring, and sooner thrown into a torpid state by cold in autumn. The principal fruits grown in orchards of this description in Great Britain are the apple, the pear, the plum and the cherry; and, wherever wheat can be ripened in the plains, these fruits will arrive at perfection on declivities such as we have mentioned.

Orchella Weed. A dye weed, yielded by several species of lichens, known to botanists under the name of *Roccella*. They are found on maritime rocks in hot and warm-temperate regions. A blue and a red dye, known as Orchil or Archil, are prepared from them.

Orchestra (Gr. ὀρχήστρα). In Music, a company of musicians (also called a *band*) assembled for the purpose of performing instrumental music.

The word *orchestra* is also used to designate the portion of the room set apart for the players.

Orchidaceæ (Orchis, one of the genera). A natural order of herbaceous Endogens, typical of the Orchidal alliance, inhabiting all parts of the world excepting the climates situated upon the verge of the frozen zone, or remarkable for their exceeding dryness. They are well-known for the singular form of their flowers. Some of them grow in the earth, while others inhabit rocks and the branches of trees. They all belong to the class *Gynandria* of Linnæus; are often very agreeably scented; and sometimes produce an aromatic fleshy fruit, as in the case of Vanilla, which contains a large quantity of benzoic acid. The nutritious substance called Salep is prepared from the amylaceous roots of several plants of this order.

Orchil. [ARCHIL; ORCHELLA WEED.]

Orchis (Gr.). A genus of terrestrial tuberous rooted Orchids, occurring chiefly in Europe, temperate Asia, and North America. Several species are common in our woods and pastures, and are known by their spreading and often spotted leaves, and erect spikes of handsome flowers. The fleshy tubers, which abound in starch, and yield the article of diet called Salep, are extensively collected in some parts of Turkey for exportation to Western Europe.

Orcin. A white crystalline substance found in the lichens used for the preparation of archil and litmus. It crystallises in six-sided prisms, which are very soluble both in water and alcohol. Exposed to air and light, orcin turns red. It has the formula $C_{14}H_8O_4$. [LICHENS, COLOURING MATTERS OF.]

Ordeal (Mod. Lat. ordalium; Ger. urtheil, *judgment*). The practice of referring litigated questions, and the guilt or innocence of parties under accusation, to the judgment of God (testified, in popular belief, either by the event of lots, or by the success or failure of certain experiments), is of very ancient date; and was transferred, with other relics of their pagan institutions, by the Teutonic nations, when settled in the provinces of ancient Rome, to their new bodies of jurisprudence. It implies necessarily an utter ignorance of an order in nature which cannot be interrupted; and the rise of physical science first weakened and then destroyed the ordeal, although it may not yet have uprooted many ideas which belong to the soil from which the ordeal superstition sprang up.

The ordeal was awarded in various cases; either arbitrarily by the court, or at the request of a party accused, who was anxious to clear himself; either as an alternative for trial by compurgation or by battle, or as the regular mode of deciding an issue. In the earlier ages of modern European history, the ordeal was under the peculiar protection of the clergy,

who afterwards discountenanced it; and its gradual suppression must be mainly attributed to the decrees of popes and councils, of which several were pronounced against it in the course of the thirteenth century, beginning with the decree of the fourth Lateran council in 1215. Among the various forms of ordeal in use among different nations, the following are some of the most remarkable. The trial of the eucharist was used chiefly among the clergy; the accused party took the sacrament in attestation of his innocence, and it was believed that if he were guilty he would be immediately visited with punishment for the sacrilege. Of the same description was the corsnedd, or trial by the consecrated piece of bread or cheese, much in use among the Anglo-Saxons. The trial of the cross was used, both in civil and criminal questions, in many European countries. See the supplementary formulæ to those of Marculfus, cited by Meyer, *Institutions Judiciaires*, liv. ii. c. vi. It appears that the litigants, or the accuser and accused, were to stand upright before a cross, and that he who fell or changed his position first was cast or condemned. This popular mode of ordeal was abolished by the capitulary of 816, in the reign of Louis le Débonnaire, as irreverent towards the mystery of the cross; but the abolition seems only to have been carried into effect in Italy and the provinces adjoining the seat of empire. The ordeal of hot water, in which the accused party plunged his hand into a vessel of boiling water, was used by the Salian Franks, when pagans, as early as the fifth century. It was afterwards extensively practised. In what was called the *expurgatio simplex*, the accused plunged his arm to the wrist; in the triple ordeal, to the elbow. Trials by burning iron were of various sorts: carrying a red-hot bar in the hand, and walking barefoot over heated ploughshares, mentioned in the imperial capitulary of 803, and adopted in England, as is well known from the celebrated example of Queen Emma. There can be no doubt that, in these severer forms of ordeal, some precaution was occasionally used by the clergy, under whose inspection and management the trial took place. There were also ordeals by lot, as by the casual choice between a pair of dice, one marked with a cross and the other blank, mentioned in the laws of the Frisons. The famous trial of the bier, in which the supposed perpetrator was required to touch the body of a murdered person, and was pronounced guilty if the blood flowed, may be regarded as a species of ordeal, although founded more on usage than legal enactment; as this form of superstition did not become prevalent until later times, when ordeals were no longer a recognised part of the law. To the same head may be referred the various absurd and cruel methods which were adopted in different countries to try suspected witches. One of the most remarkable instances of the solemn application of the ordeal in later times took place in 1498, when the truth of the doctrines preached by Savonarola at Florence was put to the test by a challenge between one of his disciples and a Franciscan friar to walk through a burning pile. This, however, may be rather regarded as the appeal of an enthusiast to the divine judgment, than as an example of a recognised usage. Ordeals are of common use in the judicial practice of various heathen nations, especially of the Hindus.

By the Anglo-Saxon laws, an option was given to the culprit in ordinary cases, when presented of a crime by the neighbourhood, or appealed against by the injured party, of defending himself by compurgation, or by the ordeal (of hot water, if noble, or of hot iron). If, being a villein, he could procure the testimony of his lord in favour of his character, the ordeal was simple; if otherwise, threefold. In the laws of William the Conqueror, we find that accusations between an Englishman and a Frenchman were decided, either by the Roman mode of trial by inquest, by battle, or by the ordeal. In general, it may be considered, as Sir F. Palgrave remarks, rather as having afforded a last chance of escape to the accused party, than as an ordinary mode of deciding on guilt or innocence; since it does not appear to have been usually resorted to, unless where the accused failed in clearing himself by the testimony of the neighbourhood to his character or to the fact. Thus torture in the civil law, according to principle, was applied only where the evidence was sufficient to warrant a conviction, and the defendant refused to confess. When, however, the old form of trial by compurgation was abolished in England by the assizes of Henry II., the trial by ordeal became more important than before. It appears that, in presentment by the inquest (whence originated the grand jury), the culprit was immediately adjudged, without option, to clear himself by ordeal; that, if he escaped this test, he was still condemned to abjure the country; so that the presentment became in some sort equivalent to a final trial. The *second* inquest or jury trial, at this period, is thought to have been only awarded as a matter of special favour. But when ordeal had been forbidden by the 18th canon of the fourth Lateran council, in 1215, as before mentioned, it was immediately disused in England; and hence, after a considerable interval, during which the practice of criminal law seems to have remained in a very uncertain state, the practice of trial by the second inquest, or petty jury, from being the exception, gradually became the general rule. (*Mém. de l'Acad. des Inscr.* vol. xv.)

Ordeal Bean. [Calabar Bean.]

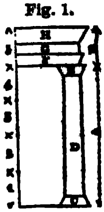
Ordeal Root. The roots of a species of *Strychnos*, used as an ordeal by the natives of Western Africa.

Ordeal-tree. The name of *Erythrophlæum guineense*. That of Madagascar is *Cerbera venenifera*.

Order (Lat. ordo). In Architecture, a system or assemblage of parts subject to certain uniform established proportions, regulated by the office which each part has to perform. An

order may be said to be the genus, of which the species are Tuscan, Doric, Ionic, Corinthian, and Composite; and consists of two essential parts—a column, A (fig. 1), and an entablature, B. These are subdivided: the first into three parts, namely, the base C, the shaft D, and the capital E; the second also into three parts—namely, the architrave, or chief beam, F, which stands immediately on the column; the frieze G, which lies on the architrave; and the cornice H, which is the crowning or uppermost member of an order. In the subdivisions certain horizontal members are used, which, from the curved forms of their edges, are called *mouldings*. These are the ovolo, the talon, the cyma, the cavetto, the torus, the astragal, the scotia, and the fillet, which are defined under their several names in this work. The character of an order is displayed, not only in its column, but in its general forms and detail. Though a building be without columns, it is, nevertheless, said to be of an order, if its details be regulated according to the method prescribed for such order.

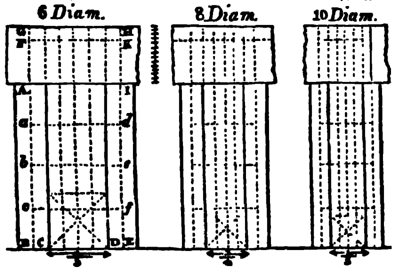
Fig. 1.



In setting up, or, as it is more technically expressed, in profiling an order, it is usual to make the entablature of the height of one-fifth of the entire order. The height of the column is measured in terms of its lower diameter, which is divided into sixty parts, called *minutes*, used as a scale for the different subdivisions. In the Doric order the semidiameter of the column is called a *module*; but as it is divided into thirty parts, there is, in fact, no essential difference between the scale of this and the other orders. The columns vary from seven to ten diameters in height in the different orders. The height of the entablature is usually divided into ten parts, of which three are assigned to the architrave, three to the frieze, and four to the cornice; except in the Doric order, in which the height is divided into eight parts, the architrave having only two, the frieze and cornice each three.

The rule above given for regulating the relative heights of the column and entablature is founded upon the practice of the ancients, who rarely exceeded or fell short of the proportion thus established. Whether this practice of assigning one-fifth of the height of the whole order to its entablature was arbitrary or empirical, is worth an enquiry, which, we are inclined to think, has not been bestowed upon it in any architectural work, at least not in any one which has fallen under our notice: though the principles developed in a work by Le Brun, entitled, *Théorie de l'Architecture Grecque et Romaine, déduite de l'Analyse des Monumens Antiques* (fol. Paris 1807), if carried through correctly, seems to point to the reason of the practice. One of the most obvious principles of proportion in respect of loads and supports, and one apparently founded on Nature herself, is, that a support should not be loaded with a greater mass than itself; or, in other words, that there should be an equality between the weights and supports; i.e. in this case, between the entablature and column. In respect of the voids left between the columns or supports below the entablature, there seems to have been a great diversity of practice; for we find them varying from 1·03 to 2·18, unity being the measure of the supports. Le Brun makes the areas of the supports, weights, and voids equal to one another; and in the monumental specimens of the Doric order, such as the Parthenon, &c., he seems borne out in the law he endeavours to establish; but in lighter specimens, such as the temple of Bacchus, at Teos, where the supports are to the voids as 1 to 2·05, and in the temple of Athena [MINERVA] Polias, where the ratio is 1 to 2·18, he can hardly be considered correct. Indeed, there scarcely seems a necessity for such a limitation of the voids as he prescribes, seeing that, without relation separately to the weight and support, stability would be obtained so long as the centre of gravity of the load fell within the external face of the support. If, then, it be admitted that, as in the two examples above mentioned, the voids should be equal to the weights and supports jointly, we have the key to the rule; and, instead of being surprised at the apparently strange law of making the entablature one-fourth of the height of the column, we shall find that none but the result assumed can flow from the investigation.

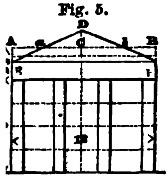
Fig. 2. 6 *Diam.* Fig. 3. 8 *Diam.* Fig. 4. 10 *Diam.*



In fig. 2, let A B be the height of the column, and let the distance between the columns be one-third of the height of the column = C D. Now, if A B be subdivided into four equal parts, at *a*, *b*, and *c*, and the horizontal lines *a d*, *b c*, *c f*, be drawn; also, if C D be divided horizontally into four equal parts, and lines be drawn perpendicularly upwards intersecting the former ones; the void will be divided into sixteen equal parallelograms, one-half of these being the measure of the two semi-supports. B C and D E being made equal then to one-fourth of C D, it will be manifest, from inspection, that the two semi-supports will jointly be equal to eight of the parallelograms above mentioned, or one-half of the void. We have now to place the weight or entablature, A G H I, upon the supports or columns and equal to them in mass. Set up

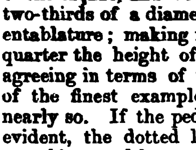
from A to F another row of parallelograms, each equal to those above mentioned, A F K I. These will not be equal to the supports by two whole parallelograms, being in number 6 only instead of 8: dividing, therefore, 8, the number in the support, by 6, the number already obtained, we have 1·333, &c., which is the height A G must be, that the weights may equal the supports, exceeding one-quarter the height of the column by only $\frac{33}{100}$ of such quarter, a coincidence singularly corroborative of the rule laid down. From inspection of figs. 2, 3, and 4, it is evident that, when the void is one-third of the height of the columns in width, the columns will be 6 diameters in height; when one-quarter of their height, they will be 8 diameters high; and when one-fifth of their height, they will be 10 diameters high; also, that the intercolumniation, called *systyle*, or of two diameters, is constant by the arrangement. Let us now try the principle in another way: Fig. 5 is the general form of a tetrastyle temple, wherein the columns are assumed at pleasure 8 diameters high: then, $4 \times 8 = 32$, the area of the supports; and as, to fulfil the conditions, the three voids are to equal twice that area, or 64, they must in all be equal to 8 diameters, for $\frac{64}{8} = 8$; and the whole extent, therefore, will be 12 diameters of a column.

Fig. 5.



To obtain the height of the entablature, so that its mass may equal that of the supports, as the measures are in diameters, we have only to divide 32, the columns, by 12, the whole extent of the façade, and we have two diameters and two-thirds of a diameter for the height of the entablature; making it a little more than one-quarter the height of the column, and again agreeing in terms of the diameter with many of the finest examples of antiquity, or very nearly so. If the pediment be employed, it is evident, the dotted lines A C, C B, being bisected in *a* and *b* respectively, that the triangles A E *a*, *b* B F, are equal to *a* D C and D C *b*, and the loading or weight will not be changed. Similar results are obtained in fig. 6, where the height is 10 diameters, the number of columns 6; the whole, therefore, 180, the supports being 60. Here $\frac{60}{18} = 3\frac{1}{3}$ diameters will be the height of the entablature.

Fig. 6.



We cannot leave the subject without adverting to the rules given by Vitruvius (chap. ii. book iii.)—rules which were the result of the practice of the time in which he lived, and which, within small fractions, singularly corroborate the assumed hypothesis of making the voids equal to twice the supports. Speaking of the five species of temples, after naming the different intercolumniations, and recommending the eustylos as the most beautiful, he thus directs the formation of temples with that interval between the columns. The rule for designing them is as follows: 'The extent of the front being given, it is, if tetrastyle, to be divided into eleven parts and a half, not including the projections of the base and plinth at each end; if hexastyle, into eighteen parts; if octastyle, into twenty-four parts and a half. One of either of these parts, according to the case, whether tetrastyle, hexastyle, or octastyle, will be a measure equal to the diameter of one of the columns. The heights of the columns will be eight parts and a half. Thus, the intercolumniations and the heights of the columns will have proper proportions.' Further on in the same chapter he gives directions on araeostyle, diastyle, and systyle temples, on which it is unnecessary here further to enlarge. Let the above rules be examined. The tetrastyle is $11\frac{1}{2}$ parts wide, and $8\frac{1}{2}$ high: the area, therefore, of its whole front will be $11\frac{1}{2} \times 8\frac{1}{2} = 97\frac{3}{4}$. The four columns will be $4 \times 8\frac{1}{2} = 34$, or a very little more than one-third of the whole area; the remaining two-thirds, speaking in round numbers, being given to the intercolumns or voids. The hexastyle is eighteen parts long, and eight and a half high: the whole area, therefore, is $18 \times 8\frac{1}{2} = 153$. The six columns will be $6 \times 8\frac{1}{2} = 51$, or exactly one-third of the whole area; the voids or intercolumns occupying the remaining two-thirds. The octastyle is $24\frac{1}{2}$ parts in extent, and $8\frac{1}{2}$ in height: $24\frac{1}{2} \times 8\frac{1}{2} = 208\frac{1}{4}$. The eight columns will be $8 \times 8\frac{1}{2} = 68$, or very little less than one-third of the area, and the voids or intercolumns about double, being the remaining two-thirds.

The average of the intercolumniations in the first case will be $\frac{11\frac{1}{2}-4}{3} = 2\frac{1}{2}$ diameters.

In the second case $\frac{18-6}{} = 2\frac{2}{5}$.

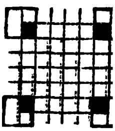
In the third case $\frac{8}{-} - 2\frac{357}{1000}$.

As, in our opinion, a discrepancy between practice and theory will not shake the principle, we are not fearful of candidly submitting a synoptical view of some of the most celebrated examples of antiquity in which a comparison is exhibited between the voids and supports. It is certain that in every case the former exceed the latter, and that, in the early Doric, the ratio between them nearly approached equality. In comparing, however, the supports with the weights, there is every appearance of that portion of the theory being strictly true; for, in taking a mean of the six examples of the Doric order, the supports are to the weights as 1 : 1·16; in the five of the Ionic order, as 1 : 1·05; and in the four of the Corinthian order, as 1 : 1·04; a coincidence so remarkable that it must be attributed to something more than accident, and deserving much more extended consideration than our limits here admit.

	Order	No. of Columns	Supports	Weights	Voids
Temple of Jupiter Nemeus	Doric	6	1·00	0·79	1·05
Parthenon	—	8	1·00	1·07	1·04
Temple at Bassæ	—	6	1·00	1 14	1·16
of Athena at Sunium	—	6	1·00	1·40	1·17
of Theseus, at Athens	—	6	1·00	1·13	1·21
of Jupiter Panhellenius	—	6	1·00	1·45	1·36
of Erechtheus	Ionic	6	1·00	0·89	1·24
of Fortuna Virilis	—	4	1·00	1·15	1·71
on the Ilissus	—	4	1·00	0·96	1·72
of Bacchus, at Teos	—	8	1·00	1·35	2·05
of Athena Polias	—	4	1·00	1·01	2·18
Portico of Septimius Severus	Corinth.	6	1·00	0·93	1·57
Maison Carrée	—	6	1·00	0 93	1 58
Pantheon	—	8	1·00	1·43	1·84

We close this short enquiry by adverting to a curious fact connected with it; viz. the area of the points of support for the edifice which such an arrangement affords. In fig. 7, the hatched squares represent the quarter piers or columns in a series of intercolumniations every way, such intercolumniations being 2 diameters, or 4 semidiameters: these, added to the 2 quarter piers, will make 6, whose square, 36, therefore, is the area to be covered with the weight; the 4 quarter piers or columns = 4; hence the points of support are $\frac{4}{36}$ of the area = 0·111. Now, in twenty-five of the principal buildings in Europe [POINTS OF SUPPORT], the ratio will be seen to be 0·168 on the mean, differing only 0·057 from the result here given; but if we take the subjoined buildings, the mean will be found to differ much less, viz.—

Fig. 7.



Temple of Peace . . .	0·127
S. Paolo fuori le Muro . .	0·118
S. Sabino	0·100
S. Filippo Neri . . .	0·129

ORDER. In the Fine Arts, the regular disposition of the parts of a work, so that neither confusion nor jarring effects may prevail.

ORDER. In Mathematics, a term frequently used synonymously with *degree*. Thus the order of a curve or surface is the same as the degree of its equation. [CURVE and SURFACE.] Although synonymous, however, when applied to ordinary algebraic equations, the terms *order* and *degree* have distinct meanings when applied to differential equations, and to equations of differences. [DIFFERENTIAL EQUATION.]

Order of the Day. In Parliamentary usage, one method of superseding a question already proposed to the House is by moving 'for the order of the day to be read.' This motion, to entitle it to precedence, must be for the order generally, and not for any particular order; and, if this is carried, the orders must be read and proceeded on in the course in which they stand. But it can be in its turn superseded by a motion 'to adjourn.' In Hatsell's *Precedents of Parliament*, vol. ii., it is stated that the first instance of this proceeding was on April 1, 1747.

Order of Superposition. A Geological term, implying the regular succession of arrangements which the strata forming the exterior crust of our globe invariably follow. [GEOLOGY.] Although certain strata or formations are occasionally wanting, they never depart from a constant order of superposition.

Orders, Holy. A term applied to the different ranks of ecclesiastical persons. The established church of England recognises only the three orders of bishops, priests, and deacons. The Roman Catholic church admits of seven orders: four minor, secular, or petty, of doorkeeper, exorcist, reader, and acolyth; three major, of deacon, priest, and bishop. The first are mere formalities, and generally conferred on the same day; the admission to the latter constitutes the sixth sacrament of Romanism: the reformed churches acknowledge only the three latter orders. [EPISCOPACY.] The Greek church rejects the four minor, but has the additional one of subdeacon. [ORDINATION.]

Orders, Rel ious orders are of three kinds: 1. Monastic; 2. Military; 3. Mendicant.

1. The Monastic orders were distinguished by the rules to which they were subjected by their respective founders. Of these the principal are the Basilian, the Benedictine, and the Augustinian.

i. The earliest comprehension of a number of conventual societies under one rule was effected by St. Basil, archbishop of Cæsarea, in Asia Minor, who united the hermits and cenobites already established in his diocese, and prescribed a uniform constitution for them, in which he strongly recommended the obligation of a vow upon admission. This recommendation was a novelty in the monastic system, which had existed up to that time (A.D. 370) without any such imposition. This institution prevailed throughout the eastern districts of Christendom, and has subsisted in the Greek church up to the present time with little variation.

ii. In the West, the first order of monks was founded by Benedict of Nursia (A.D. 529). He conceived that the ends of monastic seclusion might be better attained by a discipline uniformly imposed, than by the arbitrary austerities of many of the European communities. He insisted, moreover, very strongly upon the duties of manual labour and reading, as well as of prayer. This rule was revised three centuries later by another Benedict, a native of Aniane, in the South of France.

From this remodelled system, which was more severe than its predecessor, and was soon adopted throughout the Benedictine monasteries, already exceedingly numerous, arose various branches, all more or less famous in ecclesiastical history. The order of Cluni, the Cistercians, the Chartreux, the Camal-

dulenses, Præmonstratenses, &c. are distinct offshoots from this main trunk, and for many centuries have covered the face of Catholic Europe.

iii. The original inhabitants of the monasteries were laymen; the spiritual duties of the institution being performed by the pastor of a neighbouring village, or by one or two resident ecclesiastics. The authority of Augustine was, however, claimed for clerical societies living together under rule; and the order of Augustinian canons, consisting expressly of persons ordained or destined to the sacred profession, claims a place among the three principal monastic institutions. These canons were afterwards divided into the regular and secular, according as they observed what tradition affirmed to be the rule prescribed by the founder himself, or those of certain bishops who, in later times, had reorganised the system.

2. i. The Military orders form also an important feature in ecclesiastical and political history. The necessity under which the monks lay, in unsettled times, of assuming arms to defend their possessions, may have suggested the first idea of uniting the military with the religious profession.

The earliest order, however, of this kind—that of St. John of Jerusalem, or the Knights of the Hospital—arose, in the eleventh century, out of a religious community, to which the care of an hospital in Jerusalem had been consigned. The Hospitallers were afterwards better known under the titles of Knights of Rhodes, and, still later, of Malta.

ii. The Knights Templars also received their appellation from Jerusalem, the place of their origin and early abode. They were founded in 1118; and to them certain military duties were from the first specially prescribed, as the defence of Palestine, and the protection of pilgrims in the Holy Land. After the expulsion of the Christian arms from that region, they spread over Europe and became a very numerous and powerful body; until, having excited the fears or avarice of popes and princes, they were condemned by a council assembled at Vienna, and exterminated by a vigorous and cruel persecution.

iii. The third Military order is the Teutonic. This institution, again, was an offspring of the crusades, and a native of Palestine; originating in the officer of an hospital at the siege of Acre. On the termination of the holy wars, these knights became established [illegible], and distinguished themselves by the conquest and conversion of Prussia and Pomerania. Their order only ceased to exist when, at the Reformation, its members abandoned the cause of the papacy, and embraced the prevalent opinions of the north of Germany. To these may be added various inferior military orders, especially those of Spain and Portugal. [Calatrava and Alcantara, Orders of.]

3. The Mendicant orders were the creation of the papacy, for the advancement of its own political purposes. [Monachism.] It was in the twelfth century that the apprehensions of the Holy See were first excited by the rise and spread of heretical opinions; nor, at that period, were either the secular or the regular clergy disposed to rouse themselves from their indolence and vice to combat with these active assailants. A new ally was required, and was furnished in the order of St. Dominic, which, after completing its first mission in the extinction of the heresy of the Albigenses, was placed upon a permanent footing by a bull of Honorius III. The Franciscan friars were instituted nearly at the same time, and avowed the same principles of poverty and mendicity. 'Franciscanism,' Dean Milman remarks, 'was the democracy of Christianity; but with St. Francis it was an humble, meek, quiescent democracy. In his own short fragmentary writings, he ever enforces the most submissive obedience to the clergy. But ere long his more vehement disciple, Antony of Padua, sounded a different note; he scrupled not to denounce the worldly clergy. At Rimini, at Milan, and in other cities, he held disputations against the heretics, who yielded to his irresistible arguments. The clergy dared not but admire Antony of Padua, whom miracle began to environ. But they saw not without terror that the meek Franciscan might soon become a formidable demagogue, formidable to themselves as to the enemies of the faith. But, what is more extraordinary, already in the time of St. Bonaventura they had begun to be faithless to their hard bride, Poverty. Bonaventura himself might have found it difficult to adduce authority for his laborious learning in the rule of his master. The rule had required the peremptory renunciation of all worldly goods by every disciple of the order, and those who received the proselytes were carefully to abstain from mingling in worldly business. Not till he was absolutely destitute, did the disciple become a Franciscan. St. Francis rejected alike the pomp of ritual and the pride of learning. The Franciscan services were to be conducted with the utmost simplicity of devotion, with no wantonness of music. There was to be only one daily mass. It was not long before the magnificent church of Assisi began to rise; and the Franciscan services, if faithful to the form, began soon by their gorgeousness to mock the spirit of their master.' (*History of Latin Christianity*, book ix. ch. x.)

Our limits allow us only to mention, in addition, the Carmelites, so called from Mount Carmel, where the order originated; the Augustinians, who complete the number of the Mendicant orders; the Jesuits; and lastly, the several orders of religious women, usually styled *nuns*, from a word, as it is said, of Egyptian origin. The first nunnery is traditionally said to have been founded by St. Syncletica, a contemporary of St. Antony, in the third century. The first established in England was in A.D. 630. Many orders of

nuns are connected, by their foundation, with religious bodies of the other sex: others are of separate institution. The principal will be found noticed under their respective titles. [BENEDICTINE MONKS; CALOYERS; CAMALDULIANS; CARTHUSIANS; CELESTINES; CISTERCIANS; CLUNIACS; CORDELIERS; JESUITS; TEMPLARS; TEUTONIC ORDER; &c.]

Ordinal. The name given in England to an old work containing the ritual or religious ceremonies necessary to be performed before the ordination of a priest. It was composed in the reign of Edward VI., and revised by the English clergy in 1552.

Ordinance. An obsolete word signifying a decree or enactment. After the time of Philip the Fair (1227), the laws made by French kings were generally termed *ordinances* (ordonnance); a term which, in its most comprehensive sense, included also their edicts, declarations, and letters patent. The right to issue ordinances for the execution of the laws (equivalent to proclamations and orders in council) was conferred on the monarch by the French charters; and it was on an ambiguity of language in the clause conferring this right in that of 1814, that a defence was attempted for the illegal proceedings of the ministers of Charles X. in 1830. The best collection of the *Ordonnances des Rois de France* is that begun by order of Louis XIV., of which the first volume appeared in 1723: it extends to 12 vols. folio.

The Self-denying Ordinance, in English History, was a resolution of the Long Parliament, in 1644, by which its members bound themselves not to take certain executive offices, particularly commands in the army; the effect of which, as is well known, was the transference of power, first in the army, and then in the state, from the Presbyterian to the Independent party.

The word *ordinance* is still in use in English official language, to denote laws made by colonial legislatures appointed by the crown; those made by representative legislatures being styled *acts*.

Ordinand (Lat. ordinandus). In Ecclesiastical Antiquities, one about to receive orders; the name *ordinant* being applied to the prelate conferring orders.

Ordinary. A term of the Civil Law for any judge who has authority to take cognisance of causes in his own right, and not by delegation; used, in English law, with reference to ecclesiastical judges only. Thus, a bishop is ordinary in his own diocese; an archbishop, for the purpose of appeals, in his province.

ORDINARY. In the Court of Session in Scotland, a single judge (by courtesy styled *lord*), who sits in the *outer house* to decide causes in the first instance. There are five such judges: their decisions may be brought by appeal under review of one of the divisions of the *inner house* of the court. [SESSION, COURT OF.]

ORDINARY. In Heraldry, a portion of the escutcheon comprised between straight or other lines. It is the simplest species of charge; and many of the most ancient escutcheons known contain no other bearing, although in others, also of great antiquity, the ordinary itself is charged with other bearings. An ordinary should, it is said, comprise the fifth of the shield. The number of ordinaries in common use is considerable; among the chief are the PALE, FESS, BEND, BAR, SALTIER, CHEVRON, CROSS. Each of these is usually bounded by straight lines; but the lines may be also diversified in various manners. Thus, an ordinary bounded by serrated lines is said to be *indented*; bounded by undulating lines, *wavy*. There are many other deviations from the straight line, as *ingrailed*, *invected*, *nebuly*, *raguly*, *rayonny*, *dancetty*, *embattled* or *crenelly*, *battled embattled*, *palissy*, *angled*, *levelled*, *escartely*, *nowy*, *dovetail*, *potency*. When an ordinary has two sides, and is only varied on the upper, it is said to be *superingrailed*, *superinvected*, &c.; if only on the lower, *subingrailed*, &c.

ORDINARY. In the Navy, the establishment of the shipping not in actual service. An *ordinary seaman* is one not qualified to take the helm or sail the ship.

Ordinary of Newgate. The name given to the chaplain of the prison of Newgate.

Ordinate. In plane Cartesian Geometry, each point is determined by two *coordinates*: one of these being distinguished as the *abscissa*, while the other is termed the *ordinate*. [COORDINATES.]

Ordination. The ceremony of conferring orders in the church, which is derived, by communities that admit a regular commission and succession in the ministry from the time of the apostles, from the authority of Jesus Christ. Prayer and the imposition of hands are mentioned as forming part of the ceremony of ordination of deacons in the Acts of the Apostles; and ordination is even now conferred under similar forms in most Christian churches.

The Romish church holds ordination to be the sixth of its seven sacraments; it is regarded as a mystery or sacrament by the Greek church also; and, to a certain extent, by the High Church party in the church of England. In the Lutheran and Reformed churches, all sacramental character is repudiated, and the imposition of hands retained as a ceremony only.

In the Scotch Presbyterian church the term *ordination* is popularly but improperly (Hill's *Lectures on Divinity*) applied to the act by which a licensed preacher or probationer is inducted into the charge of a particular parish or congregation.

Ordnance. A Military term, applied generally to GUNS, MORTARS, HOWITZERS and CARRONADES. The accompanying table gives the lengths, weights, calibres, and charges of the most important pieces of ordnance in our service:—

Nature of Ordnance	Length		Weight	Calibre	Charge		Service chiefly employed for
Smooth Bored.							
Cast iron:—	ft.	in.	cwt.	inches	lb.	oz.	
10-inch gun	9	4	87	10	12	0	Land & sea serv.
8 " "	8	0	52	8·05	8	0	siege gun.
68-pounder gun . . .	10	10	112	8·12	18	0	L.S. (long ranges).
68 " "	10	0	95	"	16	0	S.S. (pivot gun).
32 " "	9	6	56	6·41	10	0	L.S. (fortresses).
32 " "	9	0	50	6·375	8	0	siege gun.
24 " "	9	6	50	5·823	8	0	" "
18 " "	8	0	38	5·292	6	0	position gun.
10-inch howitzer . . .	5	0	42	10	6	0	" "
8 " "	4	0	22	8	3	0	" "
13-inch mortar . . .	4	5	100	13	20	0	S.S. bombardment.
10 " "	3	9	52	10	9	8	" "
13 " "	3	3	36	13	9	0 maximum	L.S. "
10 " "	2	7	18	10	4	0	" "
8 " "	2	1	9	8	2	0	" "
Bronze:—							
9-pounder gun . . .	6	0	13½	4·2	2	8	field batteries.
6 " "	5	0	6	3·66	1	8	horse artillery.
24-pounder howitzer . .	4	8	12¼	5·72	2	8	field batteries.
12 " " . . .	3	9	6½	4·58	1	4	horse artillery.
Built up:—							
150-pounder gun . . .	12	3	240	10·5	35	0	naval service at close quarters.
100 " "	10	0	125	9	20	0	
Rifled.							
Muzzle-loading:—							
9-inch gun	12	3	248	9			
7 " "	11	10	140	7			
7 " "	10	5	130	7			
64-pounder gun . . .	9	3	65	6·3			
Wedge, breech-loading:—							
64-pounder gun . . .	9	2	63¾	6·4			
Vent-piece, breech-loading:—							
7-inch gun (heavy) . .	10	0	81	7	12	0	L.S. and S.S.
7-inch gun (light) . .	9	10	73	7	10	0	L.S.
40-pounder gun . . .	10	0	35	4·75	5	0	S.S. and position.
20 " "	8	0	16	3·75	2	8	position.
20 " "	5	6	12½	"	"		boat service.
12 " "	6	0	8	3	1	8	field batteries.
9 " "	5	2	6	"	1	2	horse artillery.
6 " "	5	0	3	2·5	0	12	colonial or naval.

Ordnance, Board of. The name given to the board which formerly provided the troops of the line, the artillery and engineers, the militia, and the navy, with guns, ammunition, and arms of every description. The Board of Ordnance also superintended the affairs of the regiments of artillery and engineers, the provision of forage for the whole of the troops at home, and the erection of fortifications and military works at home and abroad, &c. The Board of Ordnance was abolished during the Crimean war, and its functions are now performed partly by the War Office, and in part by the Horse Guards.

Ordonnance (Fr.). In Architecture, the right assignment, for convenience and propriety, of the measure of the several apartments, that they be neither too large nor too small for the purposes of the building, and that they be conveniently distributed and lighted. This word is seldom used, as the general arrangement of the plan of a building is thought to be more comprehensive, and the sense attributed to *ordinance* rather clashes with the meaning attributed to this one.

Ore (Norse aar, Dan. aare, Ger. ader, *a vein*, ores being frequently found running like a vein through the rock). Ores are the mineral bodies from which metals are extracted. Metals exist in the ores in one of the four following states: 1. In a metallic state, and either solitary or combined with each other; in the latter case forming alloys. 2. Combined with sulphur, forming sulphides or sulphurets

3. Combined with oxygen, forming oxides. 4. Combined with halogens and acids, forming chlorides, bromides, carbonates, phosphates, &c., which generally go by the name of *metallic salts*.

The ores which contain the useful metals constitute masses in rocks of different kinds, or are distributed in lodes, veins, nests, concretions, or beds, with stony and earthy admixtures, the whole or parts of which become the objects of mineral exploration. These stores occur in different geological formations.

The strata of gneiss and mica slate and the limestones of the carboniferous period are in Europe especially rich in the ores of the various metals. There is hardly any kind of ore which does not occur there in sufficient abundance to become the object of mining operations, and many are found nowhere else. The secondary rocks are not so rich, neither do they contain the same variety of ores. But this order of things, which is presented by Great Britain, Germany, France, Sweden, and Norway, is far from forming a general law; since in equinoctial America the gneiss is but slightly metalliferous; while the argillaceous schists, the syenitic porphyries, and several secondary deposits, yield the greater portion of the immense mineral wealth of that region of the globe.

The workable ores are few in number, being mostly sulphurets, oxides, and carbonates. These occasionally form large masses, but more frequently they are blended with lumps of quartz, felspar, and carbonate of lime, which form the main body of the deposit. The ores are arranged (1) in layers parallel to the strata of the formation, or (2) in veins which traverse the rock in all directions, or (3) in nests or concretions stationed irregularly, or finally they are disseminated in small particles. The following general observations may prove useful as presenting a condensed outline of the position of the most useful ores:—

1. *Tin* exists as stannic acid or peroxide of tin principally in granite, appearing either in interlaced masses, or as a constituent part of the rock itself, and more rarely in distinct veins. Tin-ore is also found in alluvium, filling up low situations between lofty mountains.

2. *Gold* occurs either in beds or in veins; in the former case it is frequently in crystalline rocks; though it is also found in limestone. The gold of alluvial districts occurs, as well as alluvial tin, among the débris of the more ancient rocks.

3. *Silver* is found, particularly in veins and beds, in crystalline and metamorphic rocks; though some veins of the ores of this metal occur in secondary strata. The rocks richest in it are gneiss, mica-slate, clay-slate, and some varieties of limestone. Large deposits of the richer ores of silver are rare in secondary formations; but the metal occurs in combination with the ores of copper, and is almost always present with galena.

4. *Copper* exists: 1. In crystalline and metamorphic rocks, principally in the state of copper pyrites, in beds, in masses, or in veins; 2. In stratified palæozoic rocks, sometimes in masses, sometimes in veins of copper pyrites; 3. In secondary strata, especially in beds of schist. 4. It is also found, though more rarely, native and as sub-oxide or ruby copper, and as carbonate of copper or Malachite.

5. *Lead* ores (chiefly galena) are very generally found in veins in limestone, but also in crystalline rocks. They are also found in strata in open spaces or caverns, and in veins among secondary rocks, associated with carbonate and oxide of iron and calamine (carbonate of zinc). The ores of lead are sometimes disseminated in grains through more recent strata.

6. *Iron* is met with in rocks of all kinds and of all ages. Among crystalline rocks magnetic iron-ore and specular iron-ore occur in beds, sometimes of enormous size, or in veins. The ores of red or brown oxide of iron [HÆMATITE] are found generally in veins, or occasionally in masses with sparry iron, both in crystalline and metamorphic rocks, and sometimes in secondary strata; but more frequently in the carboniferous rocks, as beds of clay-ironstone, of globular iron oxide, and carbonate of iron. In alluvial districts, we find ores of clay-ironstone, granular iron-ore, bog-ore, swamp-ore, and meadow-ore. The iron ores in crystalline rocks often exhibit a metallic aspect, with a richness amounting even to 70 per cent. of iron, while the ores in stratified formations are in general more earthy. The secondary and alluvial ores present the appearance of common stone, and afford not more than 20 per cent. of metal.

7. *Mercury*, as a sulphuret, mixed with metal, occurs principally in clay slate and old red sandstone in disseminated masses. Both the sulphuret and the native metal are met with occasionally in the coal measures, although not in Great Britain.

8. *Cobalt* occurs as arsenuret and sulphuret in veins in crystalline rocks; small veins containing this metal are also found in secondary strata.

9. *Antimony* occurs in veins among crystalline and metamorphic rocks, usually in the state of sulphuret.

10. *Bismuth* is generally met with native in quartz rock.

11. *Nickel* occurs chiefly as arsenuret or sulphuret, and almost invariably associated with cobalt.

12. *Zinc* occurs as sulphuret, or blende, in crystalline rocks; as calamine, in secondary strata, usually along with oxide of iron, and sometimes with sulphuret of lead.

As a rule, the metal of all ores requires to be converted into an oxide before smelting. This transformation into oxide is generally effected by roasting it in a current of air, either in heaps interstratified with sufficient fuel, or on the floor of a reverberatory furnace. The oxidised ore is then reduced to metal by being heated with

coal or other carbonaceous matter in a suitable furnace.

It is probable that the carbonaceous matter employed in this process is not the *immediate* agent of reduction; but that it is first transformed by the atmospheric oxygen into carbonic oxide, which gaseous product penetrates the interior substance of the oxides, decomposing them, and carrying off their oxygen in the form of carbonic acid. That this is the true mode of action, is evident from the well-known fact that an intermixture of ores and charcoal is not always necessary to reduction, but merely an interstratification of the two, without intimate contact of the particles. In this case, the carbonic acid which is generated at the lower surfaces of contact of the strata, rising up through the first bed of ignited charcoal or coke, becomes converted into carbonic oxide, which, passing up through the next layer of ore, seizes the oxygen of the latter, reduces it to metal, and is itself thereby transformed once more into carbonic acid; and so on in continual alternation. It may be laid down, however, as a general rule, that the reduction is the more rapid and complete the more intimate the mixture of the charcoal and the metallic oxide has been, because the formation of both the carbonic acid and carbonic oxide becomes thereby more easy and direct.

Oreads (Gr. ὀρειάδες). In Greek Mythology, nymphs of the mountains. [NYMPHS.]

Orelline. A colouring principle obtained from annotta (*Bixa orellana*). [BIXINE.]

Oreodoxa (Gr. ὄρος, *mountain*, and δόξα, *credit*). A genus of Palms, one species of which, *O. oleracea*, the Cabbage Palm of the West Indies, furnishes an esculent vegetable; the heart of the young leaves, which forms the *cabbage*, being eaten when boiled.

Orestes. [THESEUS.]

Orexis (Gr.). A term applied in medicine to the appetite, or a sense of hunger.

Orfray (Fr. orfroi). A species of embroidered cloth of gold, worn anciently by the kings and nobles of England, and in a less costly form by the king's guards.

Organ (Gr. ὄργανον, *an instrument*). In Biology, *organ* has diverse significations. The chief constituent idea is *work for a special end*: thus, the heart is the *organ* of circulation; the lungs, the *organ* of respiration; the liver, the *organ* of bilification, &c. But, also, incipient stages in the developement or formation of parts are called the *organs* of such; e.g. the periosteum is the *organ of bone*, the *pulp* is the *dentine organ*; other parts of the growing complex tooth are the *enamel organ*, *cement organ*, &c. The parts in which independent cells, with special powers, originate, are also called the *organs* of such; as, e.g., the ovary is the *organ of ovulation*; the *testis* the *organ of semination*. It is obvious, however, that the part which the more or less condensed cellular basis, or *stroma*, of the ovary or the testis may take in the production of the germ-cells or sperm-cells and spermatozoa, is very different from that which the heart performs in the motion of the blood, or the lungs in the mutation of the air inspired.

ORGAN. In Music, a wind instrument; so called by way of eminence, being indeed perhaps less an instrument than a machine containing a collection of instruments, or, in other words, a mechanical orchestra, under the command of a single performer's fingers on the key-board. This instrument was invented at an early period, though until the eighth century it was probably but little used. The Greeks appear to have been acquainted with it; and, in the tenth book of his *Architecture*, Vitruvius describes an hydraulic organ which was played, or rather blown, by the fall of water, but in what precise manner is not known. The emperor Julian eulogises this instrument in an epigram; and St. Jerome speaks of one, with twelve pair of bellows, which might be heard at the distance of a thousand paces; and of another, at Jerusalem, which might be heard at the Mount of Olives. Its invention is attributed to Ctesibius, a barber of Alexandria.

Large organs are usually compound instruments, containing several distinct organs enclosed in one case, and each having its own row of keys. The largest or principal of them is called the great organ; a smaller one, the choir organ; another is called the swell organ, from its being enclosed in a box with shutters that may be opened to give a swelling effect to the sound; and there is sometimes a fourth organ for special solo stops, called the solo organ. All large instruments have also a separate organ to be played upon by the feet, called the pedal organ.

The key-boards of organs vary in extent; but the compass now in general use here and on the Continent, is from C C (8 feet) to F in alt., 4½ octaves: the pedal clavier has usually a compass of 2¼ or 2½ octaves, from C C C to E or F. Each key, being pressed down with the finger, opens a valve, and admits the compressed air from the bellows into a passage formed in the sound-board, corresponding lengthwise with as many holes as there are rows of pipes; and the holes of each row are opened and shut by a register or ruler pierced with holes equal in number to the keys. By drawing the register the holes of one row are opened, because they correspond with those of the passage below; so that, by opening a valve, the air compressed in the sound-board by means of bellows finds its passage into the pipes which correspond to the open holes of the register. By pushing the register or stop, the holes therein not answering to any of those of the sound-board, the row of pipes answering to the register so pushed is shut. It is obvious, therefore, that by drawing several of these registers or stops, corresponding rows of pipes are opened.

Organ pipes are of two sorts, flute pipes and reed pipes, of each of which there are several species. Flute pipes consist, first, of a foot,

which is hollow and receives the wind that sounds the pipe; second, the body of the pipe, which is fastened to the foot. Between the foot and the body of the pipe is a diaphragm or partition, having a little long narrow aperture to let out the wind; over this aperture is the mouth, whose upper lip, being horizontal, cuts the wind as it escapes through the aperture, and sets it in vibration, so causing the sound. The pipes are made either of pewter, of lead mixed with a certain portion of tin, or of wood. The metal pipes are generally cylindrical, open at their extremities, and clear in their sound. The wooden pipes are made square on the plan, and their extremities are generally stopped with a plug or tompion covered with leather, so as to be air-tight. The sound of these is softer. The longest pipes yield the gravest, the shortest the most acute sounds. The pipes, however, which are stopped have only half the length of those that are open, for the same sound.

The reed pipes consist of a foot to carry the wind to the reed, a thin tongue of hard brass, whose extremity is fitted into a kind of mould by a wooden plug. Its other extremity is at liberty; so that the wind causes it to vibrate or shake; and in proportion to the length of that part of the tongue which is at liberty is the depth of the sound. After passing the reed, the wind traverses a long pipe whose dimensions and shape give character and quality to the sound.

The continental nations have been much in advance of the English in organ-building, the large organs of Germany and France being masterpieces of design and workmanship.

At the period of the restoration of Charles II. the organs of this country had fallen much into decay, and the art of building them was then renewed here by the celebrated Bernard Schmidt (who, to distinguish him from his nephews, Gerard and Bernard, by whom he was accompanied, obtained the name of Father Smith) and by Harris, from France. The celebrated organ at the Temple church was built by the first-named person.

The science of organ-building has of late years again revived in this country, and we have now many large organs in England which will bear favourable comparison with those abroad; among these may be mentioned those in the town halls at Birmingham and Leeds, in St. George's Hall, Liverpool, and in St. Paul's Cathedral, London.

Organ Point. In Music, the same as PEDAL POINT [which see].

Organic Analysis. That part of chemical manipulation which has for its object the ascertaining of the composition and constitution of organic compounds. These may be natural compounds whose matter has been built up under the influence of animal or vegetable life; or artificial compounds derived from the natural ones, or constructed from their elements by the skill of the chemist.

Organic analysis is first *proximate*. As each animal or vegetable has several limbs and organs, so also its tissues are composed of many different compounds. These are separated from each other by the consecutive application of mechanical disintegration, the action of solvents, and fractional precipitation, distillation, and crystallisation of the resulting products. Individuality of compounds is determined by constancy of properties: specific gravity, taste, odour, touch, appearance, boiling-point if volatile, melting-point if fusible, and especially elementary composition. In determining the last, however, another series of operations is requisite: these constitute what is known as *ultimate* organic analysis.

Organic compounds being for the most part composed of the elements carbon, hydrogen, oxygen, and nitrogen, ultimate analysis is chiefly directed to the ascertaining of the centesimal amounts of these elements. Combustibility is a characteristic of such bodies. Flesh or wood, parchment or paper, readily burn away when thrown into a fire. Moreover, at such a high temperature, and with an ample supply of air, the products of their combustion are always the same. The carbon forms carbonic acid, and the hydrogen water, whilst the nitrogen escapes chiefly in the uncombined state. The composition of carbonic acid and water is constant. Obviously, therefore, if a given weight of any organic body be burnt, and the products of its combustion be separately collected and weighed, a simple calculation will give the amounts of each element originally existing in it. This can be done with great exactness. A few grains of the substance only are operated on. This quantity, being first accurately weighed, is completely burnt by being mixed with oxide of copper and heated to redness in a long narrow glass tube closed at one end and having at the other certain arrangements for collecting the products formed. The latter pass first over some pieces of chloride of calcium, or other powerful water-absorbing body, contained in a small glass tube which has previously been accurately weighed. The increase in weight of this tube at the close of the experiment gives the exact amount of water formed: one-ninth of this is hydrogen. The products next pass through a curved and bulbed tube containing solution of potash, which has also been previously weighed. Here the carbonic acid is absorbed; and in this case also the increase in weight, when the burning is finished, gives the exact amount of carbonic acid, of which three-elevenths by weight are carbon. Nitrogen is estimated by a second distinct operation, depending either upon its measurement as gas, or its determination by weight as double chloride of platinum and ammonium. The amount of carbon, of hydrogen, and of nitrogen existing in a given weight of substance being thus ascertained, the difference between their collective weights and the weight of the substance taken will, of course,

be the weight of the oxygen which exists in that substance if the latter consist of these four elements only.

Organic Bases. Organic compounds having alkaline properties. They are mostly composed of carbon, hydrogen, and nitrogen, and sometimes oxygen or sulphur, and exist naturally in animal and vegetable tissues, or are made artificially by the chemist. Quinine, morphine, and strychnine are examples of natural organic bases, or *alkaloids* as they are commonly termed; ethylamine, aniline, and urea, are organic bases that can be artificially produced.

The composition and properties of the natural bases are well known; but their constitution, except in very few cases, has not yet been determined. They all contain nitrogen. The artificial organic bases are mostly derived from ammonia, by the replacement of its hydrogen by organic radicals, and hence it has been assumed that the natural alkaloids are similarly built up.

The prominently alkaline inorganic bases have names ending in *a* or *ia*. Thus potass*a*, sod*a*, ammon*ia*, baryt*a*, stront*ia*, magnes*ia*. The organic bases are distinguished by the termination *ine*. Thus methylam*ine*, amylam*ine*, phenylam*ine*. Their derivation from ammonia is indicated by the syllable *am*. Thus, methyl*am*ine, amyl*am*ine, phenyl*am*ine. The name of the particular organic radical which has replaced the hydrogen in the ammonia is introduced in full into the name of the base. Thus, *methyl*amine, *amyl*amine, *phenyl*-amine. The organic bases collectively are called *amines*. But these amines may be derived from a single, double, triple, or quadruple atom of ammonia. We thus have *mon*amines, *di*amines, *tri*amines and *tetra*mines. The constitution of the whole of them is seen by a glance at the following table, where $N\left\{\begin{matrix}H\\H\\H\end{matrix}\right.$ represents ammonia, this body being composed of one atom of the element nitrogen combined with three atoms of hydrogen, and R indicates an atom of any monatomic basylous radical like ethyl, R″ an atom of a diatomic radical like ethylene, and R‴ an atom of a triatomic radical, &c. [NOTATION, CHEMICAL.]

	Type	Primary	Secondary	Tertiary
Monamines	$N\left\{\begin{matrix}H\\H\\H\end{matrix}\right.$	$N\left\{\begin{matrix}R\\H\\H\end{matrix}\right.$	$N\left\{\begin{matrix}R\\R\\H\end{matrix}\right.$	$N\left\{\begin{matrix}R\\R\\R\end{matrix}\right.$
Diamines . .	$N_2\left\{\begin{matrix}H_2\\H_2\\H_2\end{matrix}\right.$	$N_2\left\{\begin{matrix}R''\\H_2\\H_2\end{matrix}\right.$	$N_2\left\{\begin{matrix}R''\\R''\\H_2\end{matrix}\right.$	$N_2\left\{\begin{matrix}R''\\R''\\R''\end{matrix}\right.$
Triamines . .	$N_3\left\{\begin{matrix}H_3\\H_3\\H_3\end{matrix}\right.$	$N_3\left\{\begin{matrix}R'''\\H_3\\H_3\end{matrix}\right.$	$N_3\left\{\begin{matrix}R'''\\R'''\\H_3\end{matrix}\right.$	$N_3\left\{\begin{matrix}R'''\\R'''\\R'''\end{matrix}\right.$
Tetramines . .	$N_4\left\{\begin{matrix}H_4\\H_4\\H_4\end{matrix}\right.$	$N_4\left\{\begin{matrix}R''''\\H_4\\H_4\end{matrix}\right.$	$N_4\left\{\begin{matrix}R''''\\R''''\\H_4\end{matrix}\right.$	$N_4\left\{\begin{matrix}R''''\\R''''\\R''''\end{matrix}\right.$

The monamine class has many members: methylamine, dimethylamine, and trimethylamine; ethylamine, diethylamine, and triethylamine; tritylamine, propylamine, amylamine, diamylamine, and triamylamine, being illustrations. The prefixes *di* and *tri* in these names have the usual signification: they indicate respectively two and three atoms of the body whose name they immediately precede. Thus diethylamine is a secondary monamine whose two radicals are ethyl. Where these syllables precede that of *am* they indicate two, three, &c. atoms of ammonia, as in the diamines. Thus diethylene-diphenyl-diamine is a tertiary diamine derived from two atoms of ammonia by the replacement of four atoms of hydrogen by two of the diatomic radical ethylene, the remaining two atoms of hydrogen giving place to two of the radical phenyl. In this diamine an illustration is also afforded of the way in which two or three atoms of hydrogen may be replaced by a single atom of a radical; that radical, however, being diatomic or triatomic, i.e. having the same saturating power as the two or three atoms of the single element.

Some organic bases contain phosphorus, arsenic, and antimony in the place of nitrogen, giving rise to phosphines, arsines, and stibines; and a few (diamines) contain both phosphorus and nitrogen, the compounds being called *phosphamines*.

The artificial organic bases are generally formed by the direct substitution of organic radicals for the hydrogen in ammonia, and to a smaller extent by the action of reducing agents upon the nitro-compounds of the same radicals. Some of them are also produced by the action of heat on nitrogenous bodies, and by the aid of fermentation and putrefaction.

Organic Compounds, Classification of. No perfect system of accomplishing this has hitherto been proposed. Hundreds of new chemical compounds and of new facts concerning old compounds are yearly discovered, whilst our knowledge of the constitution or internal arrangement of well-known compounds is still imperfect. These two circumstances alone are obviously sufficient to preclude for the present the attainment of what otherwise is so desirable. Yet some sort of system of classification must be employed, if only for purposes of convenience, generalisation, comparison, and description. Gerhardt's plan is doubtless the best hitherto proposed. According to this system a number of substances more or less connected with each other are formed into a *group* under the name of the chief acid existing among them. Thus the ethylic group, allylic group, the propionic, angelic, succinic and glucic groups. Such groups, again, are arranged under different *series*, the name of each of which is taken from that of the most prominent of the groups. Thus all the above-named groups are collectively termed the propionic series. In like manner the formic,

acetic, valeric, caprylic, stearic and other series are made up, and form collectively one great *section* of organic compounds; another section being that containing the benzoic, toluic, cuminic, and other series. The vegetable acids of secondary importance, the alkaloids and some neutral principles, with the two sections mentioned, are the divisions of Gerhardt's system. (Gerhardt, *Traité de Chimie Organique*, t. i. p. 121.)

Organic Compounds, Constitution of. The organic principles in animal tissues are derived from those of vegetable tissues, and the latter we know to be formed almost entirely from carbonic acid, water, and ammonia. All organic compounds, therefore, are probably primarily derived from these three common substances, and are in fact constructed upon them as on a framework. Adding to this triad hydrogen, the analogue of radicals, we have four bodies which may be considered typical of all organic compounds. This view is known in chemistry as the doctrine of types, and is now, with some modifications, generally adopted. [NOTATION, CHEMICAL.]

The true constitution or internal architecture of an organic body is an exceedingly difficult matter to determine experimentally. Yet it is a most fascinating branch of study, for while it affords a field for the exercise of that love of discovery which is to a greater or less extent innate in every man, it offers at the same time certain success to the patient worker—success, however, which (while thoroughly practical) is sufficiently dependent on theory to make all that relates to it continuously interesting. In short, the chemist may be said to accomplish his object by taking to pieces his compound, with the aid of all the instruments that art and nature, or rather matter and force, can furnish, and then confirming his results by putting the pieces together again. Either process alone throws great light upon his undertaking; but if both are successful, his end may be said to be accomplished.

As an illustration of the constitution of a typical series of organic compounds, see that of ammonia in the article on ORGANIC BASES.

Organic Description of Curves. In Geometry, the description of curves on a plane by means of instruments; as the circle is described by a pair of compasses, the ellipse by means of a thread passing round two pins in the foci, the epicycloids by the revolution of circles on the circumferences of other circles, the conchoid by means of the *trammel*, the cissoid by the motion of a rectangular ruler, &c. (Schooten's *Exercitationes Mathematicæ*; Newton's *Arith. Universalis*; Maclaurin's *Geometria Organica*, &c.)

Organic Disease. A disease in which the structure of an organ is morbidly altered; opposed to *functional* disease, in which the secretions or functions only are deranged, without any apparent change of organisation. Tuberculated induration of the liver is an *organic* or *structural* disease of that viscus; the secretion of viscid unhealthy bile is a *functional* derangement of it.

Organic Laws. In modern Political phraseology, the name given to laws directly concerning the fundamental parts of the constitution of a state. According to the distinction taken by some French writers, fundamental laws are merely declaratory, containing the principles or theory of government, while organic laws are those which apply those principles to the actual condition of society by positive enactment, and add the sanction of punishment.

Organic Radicals. Chemical substances which generally play the same part as the inorganic simple radicals or elements, but which are composed of two or three elements. Chlorine, sulphur, and the other electro-negative inorganic radicals, or non-metallic elements, have their organic representatives in cyanogen, acetyl, formyl, &c., while hydrogen and the positive inorganic radicals, the metals, have their organic analogues in ethyl, amyl, phenyl, &c. The organic radicals form salts analogous to inorganic salts, and both are amenable to the laws of double decomposition. Thus, for example, the compounds of the inorganic radical potassium may be tabulated in comparison with those of the organic radical ethyl in the following manner:—

Potassium . . .	Ethyl.
Oxide of potassium . .	Oxide of ethyl (ether).
Hydrated oxide of potassium (caustic potash) .	Hydrated oxide of ethyl (alcohol).
Chloride, bromide, iodide of potassium . .	Chloride, bromide, iodide of ethyl.
Cyanide of potassium .	Cyanide of ethyl.
Sulphate of potash . .	Sulphate of ether.
Bisulphate of potash .	Bisulphate of ether (sulphovinic acid).
&c. &c. &c.	&c. &c. &c.

Several of the organic radicals have been obtained in a separate state by the action of zinc upon their iodides, and by the action of nascent oxygen upon the fatty acids.

Organic Remains. [GEOLOGY.]

Organists. The old name given in the Roman Catholic church to those priests who organised or sang in parts. The name *organists of the hallelujah* was applied in the thirteenth century to certain priests who assisted in the performance of the mass. They were generally four in number, and derived their name from singing in parts, or organising the melody appropriated to the word hallelujah.

Organo-metallic Bodies. Etymologically, any organic chemical compound containing a metal is an organo-metallic body. In this sense the metallic acetates and other salts of organic acids with metallic oxides are members of this class. But conventionally, an organo-metallic body is a chemical compound in which an organic radical is directly united with a metal, whereas in the compounds just mentioned

the metal is linked to the organic part by the intervention of oxygen. These remarkable bodies are moulded on the type of the inorganic chloride or oxide, &c., of the metal existing in them. Potassium, sodium, magnesium, zinc, and cadmium form with chlorine protochlorides; their compounds with methyl, ethyl, and other radicals are proto-compounds. The chloride of aluminium is a sesqui-chloride; the only organo-compounds of that metal are sesqui-compounds. Tin forms with chlorine three chlorides; it forms with radicals three different organo-bodies. The same law also holds with bismuth, lead, mercury, antimony. arsenic, and tellurium.

The organo-metallic bodies containing highly basylous or electro-positive metals are characterised by intense chemical energy. Exposed to the air, their combination with oxygen is in some cases so rapid that heat and light are produced; or, in other words, they are spontaneously combustible, the metal burning to oxide, the carbon and hydrogen to carbonic acid and water. The relative chemical energy of organo-metallic bodies seems to be dependent on the degree of positive or basylous energy of the metal and on the smallness in weight of the organic radical. Thus zincethyl has more energetic affinities than either mercury-ethyl or zincamyl.

Organogenesis (Gr. ὄργανον, and γένεσις, *birth*). In Botany, the gradual formation of an organ, from its earliest stage.

Organography (Gr. ὄργανον, and γράφω, *I describe*). In Botany, a term usually applied to an account of the structure of plants. It comprises all that relates to the various forms of tissue of which plants are anatomically constructed; explains the exact organisation of all those parts through which the vital functions are performed; and teaches the relation which one part bears to another, with the dependence of the whole upon the common system. [BOTANY.]

Organon (Gr.). In Philosophical language, a word nearly synonymous with *method*, and implying a body of rules and canons for the direction of the scientific faculty, either generally or in reference to some particular department. For an account of the *Organon* of Aristotle and that of Bacon, see ARISTOTELIAN PHILOSOPHY and BACONIAN PHILOSOPHY respectively.

Orgeat (Fr.). A sweetened emulsion of almonds, usually flavoured by a few bitter almonds and a little orange-flower water. Mucilage of gum arabic is also sometimes added.

Orgies (Gr. ὄργια, any rites or religious performances, from ἔοργα, as ἔρδειν, *to work*, is employed in the sense of the Latin *sacra facere*). A name originally applicable to all sacrifices with certain ceremonies; afterwards, given especially to the mysteries of Dionysus (Bacchus), and then extended to mysteries in general. For the influence of foreign religious systems on the Greek orgies, see MYSTERIES.

Orgues (Fr.). In Fortification, long and thick pieces of wood shod with iron, and suspended each by a separate rope over a gate so as to be ready to be let fall and stop it up upon the approach of an enemy. The term also denotes a number of gun-barrels, so joined that they may be discharged all at once; these are sometimes used to defend breaches.

Orichalcum (Gr. ὀρείχαλκος). Literally, mountain brass. This was the name given to a peculiar kind of mixed metal in general use among the ancient Greeks and Romans. It is proved to have been made on much the same basis as brass; but various opinions have been entertained respecting the precise nature of the ingredients employed in its composition, and no definite conclusion has been arrived at on the subject.

Oriel (of uncertain derivation). In Mediæval Architecture, a projection from a building, or a recess within it, such as a closet, a window, or a private chamber.

Orient (Lat. oriens, from orior, *I rise*). The east or eastern part of the horizon. In Surveying, *to orient* a plan signifies to mark its situation or bearing with respect to the four cardinal points.

Oriental (Lat. orientalis). A term applied by lapidaries and jewellers to a variety of precious stones without any reference to the countries from which they are brought. The word *oriental* is, also, frequently coupled with the names of certain stones between which there is no relation except in colour, or some other trivial resemblance. Thus, a sapphire when it has a tinge of red, imparting to the original blue a lilac or violet colour, which thus causes it to form a sort of passage from true sapphire to ruby, is called by jewellers *Oriental Amethyst*; sapphire of a greenish-yellow colour becomes *Oriental Emerald*, and *Oriental Peridot*; or if of a yellow colour, or yellow mixed with red, *Oriental Topaz*; while reddish-brown varieties of the same gem are known as *Oriental Hyacinth*.

Oriental Alabaster. Stalagmitic carbonate of lime. In ancient times this stone is said to have been procured chiefly from Egypt. It is now obtained from the Pyrenees, Chili, and also from the province of Oran in Algeria, where a very beautiful kind has lately been rediscovered, which takes an exquisite polish, and is manufactured into ornamental articles under the name of *onyx marble*.

Orifice (Lat. orificium). The word *orifice* is used, in Engineering, to express the opening through which the steam is introduced into or from an engine, or through which water is forced; it is employed in the same sense as the word *port* in all works upon machinery.

Oriflamme or **Auriflamme** (Fr.). The ancient royal standard of France. It was the banner of the abbey of St. Denis, which was presented by the abbot to the lord-protector of the convent whenever engaged in the field on its behalf. This protectorship was attached to the countship of Vexin; and when that county

was added to the possessions of the crown by Philip I., this banner, which he bore in consequence, became in time the great standard of the monarchy. By some it is said to have been lost at Agincourt; but, according to others, its last display in the field was in the reign of Charles VII. Its derivation is uncertain: according to some, 'quasi auri flamma.' According to count de Gebelin, the last syllable is the same with *fanon* (Ger. fahne). Felibien says it was still to be seen, in 1535, in an abbey, almost devoured by moths. (*Mém. de l'Acad. des Inscr.* vol. xiii.)

Origanum (Gr. ὀρίγανον). The genus of *Labiatæ* which yields the sweet herb known as Marjoram. The Wild Marjoram, *O. vulgare*, is found in limestone and chalky districts; this yields a stimulant acrid oil sold in the shops as oil of thyme. There are two or three kinds cultivated as garden herbs, namely *O. Majorana*, the Sweet or Knotted Marjoram; *O. Onites*, the Pot Marjoram; and *O. heracleoticum*, the Winter Sweet Marjoram. They are all similar in properties.

Origanum, Oil of. The distilled or volatile oil of the wild Marjoram. It is imported from the south of Europe, and used in liniments and embrocations as a stimulant.

Origenists. An early Christian sect, who professed to draw their opinions from the writings of the celebrated Origen. They maintained that Christ was the Son of God only by adoption, and denied the endlessness of punishments. They existed in considerable numbers in the fourth, fifth, and sixth centuries; and their tenets spread among the monks of Egypt.

Origin (Lat. origo, originis). In Coordinate Geometry, a fixed point of reference whence vectors are drawn, and from which distances are measured. Thus the intersection point of coordinate axes is termed the *origin of coordinates*. In polar coordinates, the origin receives the name of *pole*. [COORDINATES.]

Original. In the Fine Arts, a work not copied from another, but the work of the artist himself. When an artist copies his own work, it is called a *duplicate*. A certain freedom and ease are always discernible in an original, which in a copy are looked for in vain; though copies have sometimes been executed which it is almost impossible to detect, and which have deceived even excellent judges and the artists of the originals themselves. These are, however, rare exceptions; copies of pictures are almost invariably more laboured and more uniform in their handling than originals.

ORIGINAL. In Law, where the several parts of an indenture are interchangeably executed between the parties, that part which is executed by the grantor is commonly called the original, the others counterparts. [INDENTURE; COUNTERPART.] But, when all the parties execute every part, all are originals. The writ which a plaintiff formerly sued out of chancery, in order to commence an action at law, was called an *original writ*; the use of it is now abolished, and a more simple form of procedure substituted. [PLEADING.]

Original Sin. The ninth article of the church of England states that original sin 'standeth not in the following of Adam, . . . but is the fault and corruption of the nature of every man that naturally is engendered of the offspring of Adam; whereby man is very far gone from original righteousness, and is of his own nature inclined to evil,' and that it 'deserveth God's wrath and damnation.' By the following of Adam is here meant the imitation of Adam; the Pelagians, against whom this article is directed, having held that the words of Scripture, 'in Adam have all sinned,' related not to any inherent vice in the race of Adam, but to the propensity of mankind to imitate his transgression. (Augustine, *De Nat. et Gratiâ.*) This doctrine of *imputed guilt* has been held by many of the stricter sects and varieties of Christians both in and out of the church of Rome; it is said by some to be the most consonant to the words of the article of the English Church above quoted, as no doubt it is to the views of the framers of it, whose sentiments were deeply tinctured with Calvinism. But, on the other hand, it has been maintained that the words of the article are as easily applicable to what is, undoubtedly, the more common opinion—that original sin is not the sin of Adam imputed to his descendants, but is that tendency to evil which (subject to a definition of the terms) philosophy, no less than religion, recognises as existing in the human mind, and developed with its growth in each individual subject.

Orillon (Fr.). In Fortification, a rounded or angular projection at the shoulder of a bastion for the purpose of covering the guns in the flanks.

Oriole (Gr. χλωρίων, Fr. loriot). A rare British bird occasionally found in our eastern counties, but common on the Continent, where its loud and flute-like voice is often heard in the obscure parts of shrubberies. In Naples it is used as an article of food.

Orion (Gr. Ὠρίων). One of the forty-eight ancient constellations formed by Ptolemy. It is situated in the southern hemisphere with respect to the ecliptic, but the equinoctial passes nearly across its middle. Orion is one of the most magnificent constellations in the heavens. It contains seven stars, which are very conspicuous to the naked eye; four of them form a square, and the three others are situated in the middle of it in a straight line. Two of the four are stars of the first magnitude; namely, Rigel in the left foot, and Betelguese in the right shoulder. The three stars in the middle of the square are of the second magnitude, and form what is called the *belt of Orion*. They are also popularly called *Jacob's staff* and the *Yard-wand*. This constellation is represented by the figure of a man with a sword by his side. Orion contains a remarkable nebula, several interesting double stars, and thousands of

small stars which are only visible in powerful telescopes.

ORION. In Mythology, a son of Hyrieus, of Hyria in Bœotia. The mythical tales of this mighty giant and hunter are more than usually various, attributing to him loves with Eos, Artemis, Aero, &c. After his death he was placed among the stars. (Homer, *Iliad*, xviii. 486.)

Orlo (Ital. *a hem or edge*). In Architecture, the plinth to the base of a column, or of a pedestal.

Orlop Deck (Dutch overloop, *that which covers*). The lowest deck of a ship, immediately above the hold. The magazines, bread-room, and certain store-rooms are on the orlop deck. It is also below the water-line, and is consequently a safe place for surgical operations during action.

Ormolu (Fr.). Bronze or copper gilt usually goes under this name. The French are celebrated in this branch of manufacture.

Ormuzd. The beneficent deity of the Zoroastrian religion as it is set forth in the Zendavesta. According to this system [DUALISM], Ormuzd, the principle of light and purity, created six immortal spirits, then twenty-eight subordinate spirits, and lastly the souls of men, while Ahriman, the opposing evil principle, produced six evil angels with sundry subordinate demons. These are all engaged in a ceaseless conflict, which is to end with the triumph of Ormuzd, when Ahriman will acknowledge his supremacy, and all creatures shall be delivered from the dominion of evil. This Zoroastrian faith inculcated no blind predestinarianism. Man was called upon to make a choice between these two powers. Both he could not serve, and his welfare or misery depended on the resolution whether he would serve God or Mammon. This duty of choosing between the two is set forth in such passages as the following: 'In the beginning there was a pair of twins, two spirits, each of a peculiar activity. These are the Good and the Base in thought, word, and deed. Choose one of these two spirits, be good, not base.' 'Ahuramazda is holy, true, to be honoured through veracity, through holy deeds.' 'You cannot serve both.'

The name Ormuzd is Sanscrit. Plato speaks of Zoroaster as a son of Oromazes, which is clearly only another form of the name of this deity. In the inscriptions at Behistun it appears in the form Auramazdâ; but the Persian language fails to explain the word. In the Zendavesta it is found both as Ahurô Mazdâo, and as Mazdâo Ahurô, while in these books the opposing power is simply spoken of as Drukhs, *deceit* (a word which seems to appear in the Greek ἀτρεκής, *true*, i.e. *not deceitful*), and has not yet received the title of Angrô Mainyus or AHRIMAN. But the Zend form leads us at once to the Sanscrit, in which it corresponds to the words Asuro medhas, *wise spirit*. (Max Müller, *Lectures on Language*, first series, v.)

Ornament (Lat. ornamentum). In the Fine Arts, there are styles of ornament, as there are styles of architecture, and there are varieties of styles. Every style has a certain class of characteristic elements, from which the period of a work of art can be ascertained: a variety of a style is a scheme of ornamentation, in which some only of the characteristic elements of the style have been introduced and made prominent. The great historic styles of ornament, omitting barbaric art, may, by careful analysis, be reduced to nine: the Egyptian, the Greek, and the Roman—ancient; the Byzantine, the Saracenic, and the Gothic—mediæval; the Renaissance, the Cinquecento, and the Louis Quatorze—modern. As varieties or substyles, may be mentioned: the Doric, Ionic, and Corinthian, or the Echinus, Voluted-Echinus, and the Acanthus orders; the Romanesque, Lombard, Norman, Siculo-Norman; Early English, Geometrical, Perpendicular, Tudor, Elizabethan, Louis Quinze, and the Rococo. (Wornum's *Analysis of Ornament, &c.* 1859.) [DECORATION.]

Ornithichnites (Gr. ὄρνις, *a bird*; ἴχνος, *a trace*). The footmarks of birds which occur in different strata. Some of these are very remarkable, as proving the existence of birds at very remote periods; for instance, at the early epoch of the new red sandstone formation. An account of these, as occurring in the red sandstone of Connecticut, is given by Professors Hitchcock and Deane in volumes recently published by them.

Ornithogalum (Gr. ὀρνιθόγαλον). This genus of Liliaceous bulbous plants, with star-shaped flowers, is chiefly interesting as being supposed to yield the Dove's-dung of Scripture. The bulbs of *O. umbellatum*, commonly called Star of Bethlehem, are wholesome and nutritious when cooked, and are eaten to this day in Palestine.

Ornitholites (Gr. ὄρνις, and λίθος, *a stone*). The name given to fossil remains of birds.

Ornithology (Gr. ὄρνις, and λόγος). The science which teaches the natural history and arrangement of birds. (See AVES for the general organical characters of the class, and the modifications of the feet by which the five orders of the Quinary arrangement are characterised.)

The subdivision of the class of birds is by no means so clearly indicated by either external or anatomical characters as that of Mammals, and the systems of Ornithology present, in consequence, greater discrepancy than the Mammalogical systems. It is not without interest to observe that if conditions of the procreative function be taken as guides to the primary division of the class, such division will present the binary character, as in the class of Mammals and of Reptiles; for example, birds may be divided into two great groups, in one of which the young are able to run about or swim and provide food for themselves the moment they quit the shell; while in the other the young are excluded feeble, naked, blind, and dependent on their parents for support. The

species comprised in the first of these groups have been termed *Aves præcoces*; those of the second *Aves altrices*.

Professor Nitzs[illegible]vided the feathered tribes into three grand p[illegible]y groups, corresponding with the three gre[illegible]visions of the matter of our planet, as air, e[illegible], and water, which constitute respectively [illegible] principal theatres of their vital actions.

This first order consists of the Raptorial and Passerine birds, pre-eminently the birds of flight, which he accordingly terms *Luft-vögeln* or *Aves aëreæ*. The second order embraces the birds of the earth, *Erd-vögeln*, *Aves terrestres*, represented by the ostrich and common fowl. The third great division includes the birds which frequent the waters, *Aves aquaticæ* (Wasservögeln), typified by the heron and the gull.

Sandewall's ornithological system has four primary groups or cohorts.

In the Quinary arrangement of birds proposed by Mr. Vigors, there may be traced a similar principle to that which guided Nitzsch in his ternary classification. Thus, the first order (*Raptores*, Virg.) includes the birds which soar in the upper regions of the air, which build their nests and rear their young on the highest rocks and loftiest trees. The second order (*Insessores*) includes the birds which affect the lower regions of the air, and which are peculiarly arboreal in their habits; whence the name of Perchers. The third order corresponds with Nitzsch's *Aves terrestres*, and is termed, as in the system of Illiger, *Rasores*. If the aquatic birds of Nitzsch be divided into those which frequent the fresh waters, and are restricted to wading into rivers, lakes, &c. in search of their food, and those which have the power of swimming or diving, and for the most part frequent the great ocean, we shall then have the two remaining orders of the Quinary arrangement, viz. *Grallatores* and *Natatores*. The chief merit of this arrangement is its aim to express the natural affinities, and their circular progression in the whole and in the several parts.

Linnæus and Cuvier have six orders of birds, which are characterised as follows by the latter naturalist:—

'Of all classes of animals, that of birds is the most strongly characterised—that in which the species bear the greatest mutual resemblance, and which is separated from all others by the widest interval. Their systematic arrangement is based, as in the Mammalia, on the organs of manducation, of the beak, and in those of prehension, which are again the beak, and more particularly the feet.

'One is first struck by the character of *webbed feet*, or those wherein the toes are connected by membranes that distinguish all *swimming birds*. The backward position of their feet, the elongation of the sternum, the neck, often longer than the legs, to enable them to reach below them, the close glossy plumage impervious to water, altogether concur with the feet to make good navigators of the *Palmipedes*.

'In other birds, which have also most frequently some small web to their feet, at least between the two external toes, we observe elevated tarsi; legs denuded of feathers above the heel-joint; a slender shape; in fine, all the requisites for wading in shallow waters in search of nourishment. Such, in fact, is the source of food of the greater number; and although some of them resort exclusively to dry places, they are nevertheless termed *shore-birds* or *waders* (*Grallæ*).

'Amongst the true land birds, the *Gallinaceæ* have, like our domestic cock, a heavy carriage, a short flight, the beak moderate, its upper mandible vaulted, the nostrils partly covered by a soft and tumid scale, and always the edges of the toes indented, with short membranes between the bases of those in front. They subsist chiefly on grain.

'Birds of prey (*Accipitres*) have a crooked beak, with its point sharp and curving downward, and the nostrils pierced in a membrane that invests its base; their feet are armed with strong talons. They live on flesh and pursue other birds; their flight accordingly is mostly powerful. The greater number still retain a slight web betwixt their external toes.

'The Passerine birds (*Passeres*) comprise many more species than all the other families; but their organisation presents so many analogies that they cannot be separated although they vary much in size and strength.

'Finally, the name of Climbers (*Scansores*) is applied to those birds in which the external toe is directed backwards like the thumb, because the greater number of them avail themselves of a conformation so favourable for a vertical position to climb the trunks of trees.'

Anterior to Cuvier, but subsequently in the order of publication, is Pallas's modification of the ornithological system of Linnæus. It is contained in his great posthumous work, entitled *Zoographia Rosso-Asiatica*. He also divides the class of birds into six orders:—

1. *Præpetes*, having the characters of the *Accipitres*, with which it is synonymous.
2. *Oscines*, including the genus *Columba*, with the *Picæ* and certain *Passeres* of Linnæus.
3. *Fringillæ*, corresponding with the *Crassirostres*, *Granivoræ*, *Enucleatrices* of Ray.
4. *Pulveratrices*, having the characters of the *Gallinæ*.
5. *Grallæ*. This order commences with the genus *Otis*, and includes, as in the system of Cuvier, the Struthious birds with the true waders.
6. *Hydrophilæ*. The characters of this order correspond with that of the *Palmipedes*, with which it is equivalent.

The primary division of the class of birds adopted by Professor Owen in the article 'Aves,' in the *Cyclopædia of Anatomy and Physiology*, includes seven orders; the Struthious birds, by virtue of their remarkable

anatomical peculiarities, being separated from the *Grallæ* of Linnæus and Cuvier. The following are the orders:—

1. RAPTORES, *Accipitres*, Linn. Cuv. Birds of prey.
2. INSESSORES, *Passeres*, Cuv. Perchers.
3. SCANSORES, Cuv. Climbers.
4. RASORES, *Gallinæ*. Linn. Cuv. Scratchers.
5. CURSORES, Illig. Coursers.
6. GRALLATORES, *Grallæ*, Linn. Waders.
7. NATATORES, *Palmipedes*, Cuv.; *Anseres*, Linn. Swimmers.

Scopoli and Latham have divided birds into *nine* orders; Temminck has *sixteen* orders; Brisson has *twenty-eight*, and Lacépède has *thirty-eight* orders; but the principles and the characters on which a classification of birds is most philosophically founded, appear to be sufficiently illustrated in the systems that have been already explained.

Ornithomancy (Gr. ὄρνις, and μαντεία, *divination*). Divination by the flight of birds. [AUGURS.]

Ornithorhynchus (Gr. ὄρνις; ῥύγχος, *a beak*). The name of the genus of Monotrematous Mammals characterised by the form of the mouth, which resembles the bill of a duck. It is peculiar to the fresh-water rivers and lakes of Australia and Van Diemen's Land. The anatomy of the *Ornithorhynchus paradoxus* has been described by Meckel, in an admirable monograph; also in the article 'Marsupialia.' (Todd's *Cyclo. of Anatomy and Physiology*.)

Ornus (Lat. *the ash-tree*). The genus of the Flowering Ash, a middle-sized tree of the temperate regions of the northern hemisphere. It is also called Manna Ash, from its yielding the saccharine matter known as manna. This substance is obtained by making incisions in the trunk, and is chiefly collected in Calabria and Sicily, where the trees are cultivated for the purpose. [MANNA.]

Orobanche (Gr. ὀροβάγχη). A curious genus of root parasites, commonly called Broomrapes. They are herbs, with brown scales instead of leaves, and brownish flowers, and are of little interest beyond that derived from the parasitism of their roots.

Oromasdes. [ORMUZD.]

Oronge (Fr. a fine sort of mushroom). *Agaricus cæsareus*, one of the best and handsomest of fungi, celebrated among the Romans under the name of *Boletus*.

Orontiaceæ (Orontium, one of the genera). A natural order of Monocotyledons belonging to the Juncal alliance; sometimes united with Arads. They are known by their spadiceous hermaphrodite flowers, and by their axile embryo with a lateral cleft. *Orontium*, *Calla*, *Acorus*, and *Pothos* are familiar examples. The properties of this order are acrid. *Orontium*, a North American marsh plant, is the type of the order.

Oropion. [ROCK SOAP.]

Orpheus (Gr.). In Mythology, according to the common story, a son of the Thracian river Æagrus and the muse Calliope. His power of moving inanimate things by music, the share he bore in the Argonautic expedition, his descent into the Shades to recover his wife Eurydice, and his death by the violence of the Thracian women, are well known. The name is identified by Professor Max Müller with the Sanscrit Arbhu, used in the Veda as an epithet of Indra, or the sun. (*Comparative Mythology*, 79.) But Dr. Kuhn affirms the Ribhus (another form of the same name) to be embodiments of the winds [HERMES], which tear up the trees as they course along, chanting their wild music. (Kelly, *Curiosities of Indo-European Folklore*.) But if this be so, then this myth exhibits a process the reverse of that which is displayed in the legend of Hermes, in which a name for the dawn has been gradually connected with incidents which can be explained only by the action of wind, i.e. of air in motion. It is equally obvious that, if we put aside the power of song which allures all living things to follow him, the details of the Orphic legend are entirely solar. Eurydice is one of the many names of the dawn (like Euryphaëssa, Eurynome, Euryanassa, Eurymedusa, &c.). On her death, after she is stung by the serpents of the night (which attack and are strangled by Heracles), Orpheus descends to seek her in the regions below the earth, as Indra seeks for Dahanâ, or Phœbus for Daphnê, and brings her up behind himself in the morning, only to destroy her by his brightness when he turns to look upon her, as Kephalos slays Procris, or, in other words, as the sun dries up the dew. (Max Müller, *Comparative Mythology*, 79.)

What passed as the poetry of Orpheus in the time of Aristotle, seems to have been as supposititious as the poems which we possess under the same name, some of which are thought to be as recent as the fourth century after Christ. According to modern theories, the Orphic poetry of ancient times contained the whole body of Greek esoteric religion. (Lobeck's *Aglaophamus*; Bode's *Orpheus*; Tiedemann, *Initia Philosophiæ Græcæ*; *Mém. de l'Acad. des Sciences* vol. xii.)

Orphic Mysteries. At the first rise of Greek philosophy, certain societies assumed the name of Orpheus, and celebrated mysteries very different from those of Eleusis. Their character seems to have been on the whole ascetic. For the nature of their theogony and philosophy, see Grote's *History of Greece*, part i. ch. i. The members of the Orphic brotherhoods must be distinguished from the obscure sect of the Orpheotelestæ, who went about undertaking to release people from their sins by songs and sacrifices. (Smith's *Dictionary of Greek and Roman Biography*, art. 'Orpheus.')

Orpiment (Lat. auripigmentum). Native tersulphide of arsenic; it forms the basis of the yellow paint called *king's yellow*. The solution of orpiment in ammonia has been used as a yellow dye. On the exhumation of the bodies of persons poisoned by white arsenic

(arsenious acid), the remains of that substance in the stomach are frequently changed to this yellow sulphide by the sulphur derived from the decomposition of the tissues.

Orpin (Fr.). In Painting, a yellow colour of various degrees of intensity, approaching also to red.

Orpine. The English name for the succulent herbaceous plant called by botanists *Sedum Telephium.*

Orrery. A machine for representing to children the motions and relative magnitudes and distances of the bodies composing the solar system. As these machines are often procured by well-meaning but ignorant people at considerable expense, it may be useful to quote an authority that will not be called in question. 'As to getting correct notions on the subject' (the magnitudes and distances of the planets), says Sir John Herschel, 'by drawing circles on paper, or, still worse, from those very childish toys called orreries, it is out of the question.' ('Astronomy,' *Cab. Cyc.* p. 287.) For the description of an orrery, see Ferguson's *Astronomy,* by Brewster.

For the origin of the name, it is said that about the year 1700 one Graham made such a machine, which the instrument maker who had to forward it to Prince Eugene copied. This copy he sold to the earl of Orrery, who showed it to Steele, and the latter spoke of it as an orrery, a name which it has ever since retained. (*Ency. Brit.* art. 'Planetary Machines.')

Orris Root. The root of the *Iris florentina.* It has an agreeable odour, much like violets, and is used in the manufacture of perfumed powders; it is also turned into little balls for issues, called *orris peas.*

Orsedew. Brass leaf. Dutch or Mannheim gold.

Orsellic Acid. The product of the action of alkalies on lecanoric acid, which is one of the substances derived from lichens. It is salifiable.

Orthite (Gr. ὀρθός, *straight*). A variety of Allanite, which occurs massive and also in long, thin, acicular crystals. It is of a blackish-grey colour, and either opaque or only slightly translucent when reduced to thin splinters. It is found in Sweden at Finbo and Ytterby, and in the island Skeppsholm near Stockholm, at Arendal in Norway, and in the Ural.

Orthocerata (Gr. ὀρθός, and κέρας, *horn*). The name of a family of Cephalopods with chambered siphoniferous shells, which are straight, or are continued straight after commencing with a greater or less curvature, thus resembling a horn.

Orthoclase (Gr. ὀρθός, and κλάω, *I cleave*). Common or Potash Felspar. A silicate of alumina and potash; but a portion of the potash is frequently replaced by lime, soda, magnesia, &c. It occurs in crystals which are generally white, reddish-white, or greyish, and translucent. Potash Felspar enters into the composition of many rocks, and is one of the ordinary ingredients of granite. In England, Orthoclase is found in large crystals, in most of the granite of Cornwall. It is also found at Rubislaw in Aberdeenshire, and in claystone-porphyry at Drumadoon in Arran. The opaque-white and twin crystals from the Mourne Mountains of Ireland resemble those from St. Gotthard. [FELSPAR.]

Orthodox (Gr. ὀρθόδοξος). In Ecclesiastical History, a title assumed by the Eastern or Greek Church. As denoting a right judgment in matters of religious faith, the word has been applied by theologians of different schools or churches to signify persons whose convictions agree substantially with their own.

Orthodromics (Gr. ὀρθοδρομέω, *I run straight forwards.*) In Navigation, sailing on a right course, or on the arc of a great circle, which is the shortest distance between two points on the sphere.

Orthoëpy (Gr. ὀρθός, and ἔπος, *a word*). In Grammar, this term signifies literally the right use of words; but it is applied, at least by modern writers, to signify that part of prosody which treats of the manner of uttering words, or of pronunciation in its limited sense. [PRONUNCIATION.]

Orthogonal (Gr. ὀρθός, and γωνία, *angle*). In Geometry, the same as rectangular or right-angled.

Orthographic Projection. The projection of points on a plane by straight lines at right angles to the plane. [PROJECTION.]

Orthography (Gr ὀρθογραφία). That part of Grammar which relates to the method of denoting sounds by visible signs, to the different kinds of letters, and their combination into syllables and words.

ORTHOGRAPHY. In Architecture, a geometrical representation of an elevation or section of a building.

Orthomorphic (Gr. ὀρθός; μορφή, *shape*). That period in the developement of organised beings in which their full perfection is attained, prior to the formation of spermatic and germinal elements.

Orthopædia (Gr. ὀρθός, and παιδεία, *the bringing up of children*). That department of Medicine and Surgery which relates to the prevention and cure of deformity.

Orthopnœa (Gr. ὀρθόπνοια). A difficulty of breathing, which is increased by any deviation from the erect posture.

Orthopterans (Gr. ὀρθόπτερος, *with upright feathers*). An order of insects, including all those species which have the wings disposed, when at rest, in straight longitudinal folds. Latreille characterises the insects of this order as having the body generally less firm in texture than in the Coleoptera, and covered by soft semi-membranous elytra furnished with nervures, which, in the greater number, do not join at the suture in a straight line. Their wings are folded longitudinally, most frequently in the manner of a fan, and divided by membranous nervures running in the same direction. The maxillæ are always terminated by a dentated and horny piece covered with a

galea, an appendage corresponding to the exterior division of the maxillæ of the Coleoptera. They have also a sort of tongue.

The *Orthoptera* undergo a semi-metamorphosis, of which all the mutations are reduced to the growth and developement of the elytra and wings, that are always visible in a rudimental state in the nymph. As both this nymph, or semi-nymph, and the larva are otherwise similar to the perfect insect, they walk and feed in the same way.

The mouth of the *Orthoptera* consists of a labrum, two mandibles, as many maxillæ, and four palpi: those of the jaws always have five joints; whilst the labial palpi, as in the Coleoptera, present but three. The mandibles are always very strong and corneous, and the ligula is constantly divided into two or four thongs. The form of the antennæ varies less than in the Coleoptera, but they are usually composed of a greater number of joints. Several, besides their reticulated eyes, have two or three ocelli. The inferior surface of the first joints of the tarsi is frequently fleshy or membranous. Many females are furnished with a true perforator formed of two blades, frequently enclosed in a common envelope, by means of which they deposit their eggs. The posterior extremity of the body, in most of them, is provided with appendages.

All the known *Orthoptera*, without exception, are terrestrial, even in their first two states of existence. Some are carnivorous or omnivorous, but the greater number feed on living plants.

Orthotomic Circle. A name given by Prof. Cayley (*Quart. Journ. of Mathematics*, vol. 1857) to the circle which cuts at right angles (orthogonally) each of three given circles. Its centre obviously coincides with the radical centre of the three circles, and its radius is equal to the tangent from its centre to any one of the given circles. It can readily be shown that the polars, with respect to these circles, of any point on their orthotomic circle, meet in another point of the latter, diametrically opposite the former point; and hence may be deduced a very simple demonstration of an elegant theorem of Dr. Salmon's, according to which the equation of the orthotomic circle is found by equating to zero the Jacobian of the three ternary quadrics which correspond to the equations of the three given circles. [JACOBIAN.]

Orthotropal (Gr. *ὀρθός, straight*; *τρέπω, I turn*). In Botany, a term applied to ovules in which the nucleus is straight and has the same direction as the seed to which it belongs, the foramen being at the end most remote from the hilum.

Orthros. In Greek Mythology. [CERBERUS.]

Ortolan. The name given in France and England to a species of *Fringillidæ* (*Emberiza hortulana*) greatly esteemed for the delicacy of its flesh when in season. It is the *ortolano* of the Italians, and the *fettammer* of the Germans. The ortolan is a native of Northern Africa; but in the summer and autumnal months it resorts to Southern Europe, and frequently migrates to the central and even the northern parts. There are large establishments in Italy and in the South of France for feeding these birds, the flesh of which is styled by Prince Musignano *carne squisita*.

Ortygia (Gr. Ὀρτυγία). In Greek Mythology, a surname of Artemis, derived generally from her mythical birthplace Ortygia, which was said to be another name for Delos, or for a small island off Syracuse. Delos, however, is simply the *bright* island [PHŒBUS; LYCAON], and Ortygia, though localised afterwards in different places, is also the dawn or the dawn-land. 'Ortygia is derived from ortyx, *a quail*. The quail in Sanskrit is called *vartikâ*, i.e. the returning bird, one of the first birds that return with the return of spring.' It thus became one of the names of the dawn: 'Hence Ortygia, the quail-land, the east, the glorious birth, where Leto was delivered of her solar twins, and Ortygia, a name given to Artemis, the daughter of Leto, as born in the East.' (Max Müller's *Lectures on Language*, second series, p. 506.)

Orus or **Horus.** An Egyptian god, son of Isis and Osiris, according to Herodotus (ii. 144). He frequently appears in Egyptian paintings sitting on the lap of Isis.

Orvietan. An antidote to poison, said to have been invented by a mountebank of Orvieto in Italy.

Orycteropus (Gr. *ὀρύκτης, a digger*, and *ποῦς, a foot*). A genus of edentate Mammalia, closely allied to the armadillos, found in Southern Africa, and termed AARDVARK by the Dutch boers. It feeds exclusively upon ants, in this respect according with the pangolin of Asia, the ant-eater of America, and the echidna of New Holland. Its outward appearance closely resembles that of a short-legged pig, and it frequents the vicinity of ant-hills, where it preys upon the insects found therein. The genus is exemplified by one species, the *O. capensis* of the Cape of Good Hope.

Oryza (Arab. aruz). The name by which Rice was known to the ancient Greeks and Romans, and which has been adopted by modern botanists as the generic name of the plant yielding that invaluable grain. The genus *Oryza* belongs to the *Graminaceæ*, and has two glumes to a single flower, two pales nearly equal adhering to the seed, six stamens and two styles. It affords many varieties, of which the most common is the *Oryza sativa*, or Rice of commerce. This plant is raised in immense quantities in India, China, and most Eastern countries; also in the West Indies, Central America, and the United States; and in some of the southern countries of Europe. It occupies, in fact, the same place in most intertropical regions as wheat in the warmer parts of Europe, and oats and rye in the more northern. Forming, as it does, the principal part of the food of the most civilised and populous Eastern nations, it is more extensively consumed than any other species of grain. It is light and wholesome, but less nutritious than wheat. When rough, or in its natural state in the husk, it is called *paddy*.

There is an immense variety in the qualities of rice. That which is principally exported from Bengal has received the name of *cargo* rice. It is of a coarse reddish cast, but is sweet and large-grained, and is preferred by the natives to every other sort. It is not kiln-dried, but is parboiled in earthen pots or caldrons, partly to destroy the vegetative principle, so that it may keep better, and partly to facilitate the process of husking. Patna rice is more esteemed in Europe than any other sort of rice imported from the East. It is small-grained, rather long and wiry, and remarkably white. But the rice raised on the low marshy grounds of Carolina is superior to the rice brought from any part of India.

The produce of lands naturally or artificially irrigated is, as far as rice is concerned, from five to ten times greater than that of dry land having no command of water; and hence the vast importance of irrigation in all countries where this grain is cultivated. But owing to the not unfrequent occurrence of severe droughts, there is a greater variation in the crops of rice than in those of any other species of grain. Those who, like the Hindus, depend almost entirely on it for subsistence, are consequently placed in a very precarious situation. There can be no doubt that famines are more frequent and severe in Hindustan than in any other quarter.

A few years ago, England was principally supplied with cleaned rice from Carolina. Latterly, however, the imports of Carolina rice have been much reduced. An improved method of separating the husk, which throws out the grain clean and unbroken, has recently been practised in this country; and as the grain when in the husk is found to preserve its flavour and sweetness better during a long voyage than when shelled, large quantities are now imported rough from Bengal and the United States.

In 1864 the imports of cleaned rice amounted to 3,189,691 cwt., of the computed value of 1,810,022*l.*

Os Frontis (Lat.). The frontal bone of the skull, which covers the upper part of the prosencephalic lobe of the brain.

Oschophoria (Gr.). A celebrated festival observed by the Athenians in honour of Dionysus and Athena, or, as others have thought, Ariadne. The name is derived from *ὄσχος* or *ὄσχη*, a vine branch with grapes. In this vintage feast, two youths, called Oschophori, dressed as women, carried such branches from the temple of Dionysus in Athens to that of Athena Skiras in Phalerum.

Engines in which the steam is introduced through the *trunnions*, or the bearings upon which the system turns, to enter the valve casing, thus causing the cylinders to oscillate. In such engines the parallel motion and the connecting rods are dispensed with, the head of the piston rod being attached directly to the crank pin; but the parts are very complicated. Oscillating engines are largely employed in steam navigation, for which they are well adapted in consequence of their lightness and compactness.

Oscillation (Lat. oscillatio). In Mechanics, the vibration or alternate ascent and descent of a pendulous body. [PENDULUM.] The *centre of oscillation* is a point in the oscillating body, such that if all the matter of the body were there collected the oscillations would be performed in the same time. The distance between the centres of oscillation and suspension, therefore, is equal to the length of an isochronous simple pendulum. The centres of oscillation and suspension may be interchanged without affecting the period of oscillation. This remarkable property was noticed by Huygens, and was first practically applied to the purpose of finding the length of the seconds pendulum by Captain Kater. The application is made as follows: Let a bar of iron, for example, about four feet long, be suspended from a point A, at the distance of four or five inches from one of its extremities, and observe the number of vibrations it makes in a given time. Then suspend it from another point B, near its other extremity, and let the point of suspension B be moved backwards or forwards till the bar makes exactly the same number of vibrations in a given time as when it was suspended from A. Then the distance between A and B is the length of the isochronous simple pendulum.

Oscillatoria. Minute filamentous organised beings which have the faculty of exercising oscillatory movements. [ACRITA.]

Oscula (Lat. osculum, dim. of os, *a mouth*). The larger and more prominent orifices in Sponges, out of which the currents of water flow.

Osculating Circle. The circle whose contact with a given curve is three-pointic or of the second order. It coincides with the circle of curvature. [CONTACT; OSCULATION.]

Osculating Elements. In Astronomy, the elements of an orbit corrected to any epoch for the effect of planetary perturbation.

Osculating Helix of a Non-Plane Curve. The common helix which passes through three consecutive points, and has its axis parallel to the rectifying line of the curve. It has, in common with the curve, an osculating plane, two consecutive rectifying planes, and therefore two principal normals. Its radii of curvature and torsion are equal to those of the curve. In general, however, it has not the same osculating sphere as the curve, and therefore not a fourth common consecutive point; since the centre of this sphere, in the case of the helix, coincides with the centre of absolute curvature [HELIX], whilst for the curve this is usually not the case.

Osculating Plane. The plane passing through, and determined by, three consecutive points of any curve in space. Two consecutive osculating planes intersect in a tangent, and three in a point of the curve. Hence, the successive osculating planes envelope a develop-

able surface, called the *developable osculatrix*, of which these tangents are the generators and the curve itself the *cuspidal edge* or edge of regression.

Osculating Right Cone of a Non-Plane Curve. A right cone, three consecutive tangent planes of which coincide with three consecutive osculating planes of the curve. The rectifying planes of the curve being perpendicular to the osculating planes, it is obvious that two consecutive rectifying planes must intersect in the axis of the osculating right cone. The latter, therefore, may be also defined as the right cone whose axis is the rectifying line, and generator the tangent at the point of the curve.

Some writers, chiefly continental ones, have also given the name *osculating right cone* to the cone of revolution which is circumscribed to the osculating sphere along the circle of curvature.

Osculating Sphere. The sphere which passes through, and is determined by, four consecutive points of a curve of double curvature. The centre of such a sphere being a point in each of three successive normal planes, lies in the cuspidal edge of the polar developable.

Osculation (Lat. osculatio, from osculor, *I kiss*). In Geometry, one curve is said to osculate another when the number of consecutive points of the latter through which it passes suffices for the complete determination of the first curve.

The theory of osculating curves in general is most easily explained by the methods of the differential calculus. Let $y=f(x)$ and $y=F(x)$ be the equations of two curves; suppose x to become $x+h$, and let the functions

$$f(x+h),\ F(x+h),$$

be developed by Taylor's theorem; then, if all the terms of the first developement are respectively equal to the corresponding terms of the second, the curves are the same in every respect, or coincide. If the first terms only are equal, the two curves have only one common point; if the two first terms of the one developement are respectively equal to the two first of the other, then two contiguous points coincide, or are common to both curves; if the three first terms in each are respectively equal, the curves have three common points, and so on. Now the number of terms of the first developement which can be made equal to the corresponding terms of the second depends on the number of constants in the function $f(x)$. For instance, the equation of a straight line being $y=ax+b$, contains two constants; the straight line can thus be made to have two contiguous points in common with a curve: it then becomes a tangent, and the contact is said to be of the first order. Again, the general equation of the circle is $(y-b)^2+(x-a)^2=r^2$, and contains three constants; a circle can therefore be determined which shall have three consecutive points in common with a curve: it then *osculates* the curve, and the contact is said to be of the second order. The general law is now obvious. It is a consequence of this theory that no osculating curve having a contact of inferior order can be made to pass between two curves having a contact of a higher order: for example, no straight line can be drawn through a point on a curve so as to pass between it and its osculating circle at that point. (Lagrange, *Théorie des Fonctions Analytiques*; Lacroix, *Traité du Calcul Différentiel et Intégral*.)

Osculatrix, Developable. [Developable Osculatrix.]

Oserskite. A variety of Aragonite from Nertschinsk.

Osiandrians. In Ecclesiastical History, a sect among the Lutherans; so called from their founder, Osiander. They differed from the followers of Luther and Calvin as to the efficient cause of justification.

Osier (Fr.). The name given to various species of Willow or Salix, chiefly employed in basket-making on account of their tough flexible shoots. (See Loudon's *Arboretum Britannicum*, p. 1490, which contains full information on all the points relative to osiers.)

Osiris. In Mythology, one of the chief Egyptian divinities, the brother and husband of Isis, and together with her the greatest benefactor of Egypt. After visiting the greater part of Europe and Asia, he found on his return his own subjects excited to rebellion by his brother Typhon, by whose hand he was killed. His principal office, as an Egyptian deity, was to judge the dead, and to rule over that kingdom into which the souls of the good were admitted to eternal felicity. The characters of Osiris, like those of Isis, who was thence called Myrionymus, or 'with 10,000 names,' were numerous. He was that attribute of the deity which signified the divine goodness; and in his most mysterious and sacred office, he was superior to any even of the Egyptian gods; for, as Herodotus observes, though all the Egyptians did not worship the same gods with equal reverence, the adoration paid to Osiris and Isis was universal. He was styled the *Manifester of Good*, as having appeared on earth to benefit mankind: and after falling a sacrifice to Typhon, the evil principle (which was at length overcome by his influence after his leaving the world), he 'rose again to a new life,' and became the 'judge of mankind in a future state.' Other titles of Osiris were: *Lord of the East*, *Lord of Lords*, *Eternal Ruler*, *King of the Gods*, &c. These, with many others, are commonly found in the hieroglyphic legends accompanying his figure; and the Papyri frequently present a list of forty-nine names of Osiris in the funeral rituals. Osiris was particularly worshipped at Philæ and Abydus: so sacred was the former, that no one was permitted to visit it without express permission; and the latter was regarded with such veneration that persons living at a distance from it sought, and with difficulty obtained, permission to possess a

sepulchre within its necropolis. The worship of Osiris was at a later period introduced into Rome; but the prurient imagination of the Romans soon converted the rites and mysteries of this deity into an occasion of the most unbounded licentiousness, which at length reached such a height that his worship was prohibited by law. Osiris was venerated under the form of the sacred bulls Apis and Mnevis; or as a human figure with a bull's head, distinguished by the name Apis-Osiris. (Plutarch, *On Isis and Osiris*; Sir G. Wilkinson, *Manners and Customs of the Ancient Egyptians*.) [ISIS.]

Osmazome (Gr. ὀσμή, *odour*, and ζωμός, *broth*). The extractive matter of muscular fibre, which gives the peculiar smell to boiled meat, and flavour to broth and soup.

Osmelite (Gr. ὀσμή). A silicate of lime, with soda, potash, and a small quantity of oxide of iron, found in thin radiating prismatic concretions of a greyish-white colour at Niederkirchen on the Rhine. The name has reference to the argillaceous odour given out by it when breathed on.

Osmic Acid. The peroxide or tetraoxide of the metal osmium. It is produced when the metal is fully oxidised by burning in air or oxygen, or boiling with nitric acid. It is white, has a disagreeable odour, fuses, and ultimately volatilises, when heated, with production of acicular flexible crystals. It is soluble in water, stains the skin, is very poisonous, and combines with bases to form salts.

Osmiridium. A native alloy of osmium and iridium. [IRIDOSMINE.]

Osmium (Gr. ὀσμή, *odour*). A metallic substance found associated with the ore of platinum: its peroxide is extremely volatile, and has a peculiar pungent odour, which suggested the name of the metal. Neither osmium nor its compounds have been applied to any use, and it is a rare substance.

Osmose. Liquid diffusion through a membrane is thus termed by Graham. For example, the mouth of a funnel is tied over with bladder filled with spirit of wine and placed in shallow water. The water passes through to the spirit, and the spirit through to the water; the one action is *endosmotic*, the other *exosmotic*. But these actions are unequal in amount in a given time. The water gets through to the spirit faster than the spirit goes out to the water, and consequently, in opposition to gravity, the fluid rises in the neck of the funnel, and, if allowed, will overflow. The explanation is, that adhesion is greater between membrane and water than between membrane and spirit; the membrane therefore takes up more of the former than of the latter, and consequently is in a position to give more of the former to the spirit than of the latter to the water. So alkaline and acid solutions are powerfully osmotic, though in opposite directions, the former positively (exosmotic), the latter negatively. Acid salts resemble acids, but strictly neutral salts have little or no osmotic action.

Osprey (Lat. ossifraga, literally *bone-breaker*; but the Latin name was not applied to the bird now denoted by the term). The Bald Buzzard or Fishing Eagle (*Pandion haliætus*) is widely diffused over the northern portion of both hemispheres. It is a powerful bird, the female sometimes weighing five pounds avoirdupois. It is not to be confounded with the Bald or Sea Eagle (*Haliætus leucocephalus*), which, like it, preys on fish, but is of much greater size and power.

Osseans or **Pisces Ossei** (Lat. *bony fishes*). In Ichthyology, a primary division of the class of fishes, including all those which have a true bony skeleton.

Osseous Breccia. A breccia or conglomerate made up altogether or partly of bones cemented by carbonate of lime or oxide of iron. They are sometimes called *bone breccias*. Osseous breccias are not uncommon in caverns and in fissures of limestone rock; and among them have been found human remains associated with the bones of extinct animals, such as the cavern bear and hyæna, the Irish elk, and some others. [BRECCIA.]

Ossian's Poems. The name given to a collection of poems, said to have been composed by Ossian, the son of Fingal, a Scottish bard, who lived in the third century They were first given to the world in an English version by James M'Pherson, in 1760, with the assurance that they were translations made by himself from ancient Erse manuscripts which he had collected in the Highlands of Scotland; and such was the enthusiasm which their appearance excited, that they may be almost said to have given a new tone to poetry throughout all Europe. There were not, however, wanting many distinguished persons who from the first denied their authenticity. Foremost among these was Dr. Johnson, who boldly pronounced the whole of the poems ascribed to Ossian to be forgeries; and his opinion was corroborated by Hume, Gibbon, and many others, who defied M'Pherson to produce a manuscript of any Erse poem of earlier date than the sixteenth century. On the other hand, M'Pherson's assertions as to the genuineness of the poems found warm supporters in Dr. Blair (*Critical Dissertation on the Poems of Ossian*), Dr. Henry, Lord Kaimes, and many other distinguished names, and almost to a man in the whole body of the Highlanders. In this unsettled state the controversy remained till the year 1800, when Malcolm Laing, in a Dissertation appended to the second volume of his *History of Scotland*, endeavoured to establish, from historical and internal evidence, that the so-called poems of Ossian are absolutely and totally spurious. The sensation created by this Dissertation was unprecedented. Many converts were made to the opinions therein set forth; but the general disbelief in the authenticity of the poems was not complete till 1805, when a committee of the Highland Society of Edinburgh, which had been appointed in 1797 to enquire into their nature and authenticity, reported to the effect

'that they had not been able to obtain any one poem the same in title and tenour with the poems of Ossian.' Since that period the controversy, so far as it regards their translation from Erse manuscripts, may be said to be terminated. But although these poems had never been committed to writing, or rather have not been handed down in writing, there can be, we believe, but little doubt that many of them still exist in the Highlands of Scotland in a dress not very different from that in which they were rendered by M'Pherson into English, having been committed to memory, and transmitted from one bard or storyteller to another in regular succession; and consequently their authority on points of social life and manners may be scarcely less than that of the Homeric Poems. Their scene is sometimes laid in Scotland, but more frequently in Ireland; and they may be justly considered the *Iliad* and *Odyssey* of the Celtic race of the two islands, handed down by tradition only—what the Homeric poems were, in all likelihood, to the Greeks themselves before they were acquainted with the art of writing. [Epic.] 'The value of Ossian,' says Mr. Skene, 'as an historical poet, must stand in the highest rank; while, whether the chief part of these poems are of ancient or of modern composition, there can remain little doubt that in him we possess the oldest record of the history of a very remote age.' (*The Highlanders of Scotland, their Origin, History, and Antiquities*, vol. i. p. 215.) Those who wish to see this subject exhibited in all its bearings, though, perhaps, with a slight prejudice against M'Pherson, may consult the elaborate article in the *Edin. Review*, vol. vi.

Ossification. The formation of bone. The change of any soft solid of the body into bone.

Ostara. An ancient German and Celtic divinity, worshipped with peculiar veneration by the Anglo-Saxons. Many writers regard her as identical with the Phœnician goddess Astarte; but, be this as it may, she was regarded as the queen of spring and of the morning; and from her name is derived the German *Ostern* (Anglicè, *Easter*), which period of the year the ancient Germans were in the habit of celebrating with fires and festivals in gratitude for the advent of spring. (Grimm's *Deutsche Mythologie*, p. 181.)

Osteodentine (Gr. ὀστέον, and Lat. dens, *a tooth*). That modification of dentine in which the tissue is traversed by irregularly disposed and ramified vascular or medullary canals, and in which some of the branches of the dentinal tubes communicate with cells, like the radiated cells of true bone. This modification of dentine is found in the central part of the tooth of the cachalot and some other cetaceans; also in the teeth of the cestracion, acrodus, lepidosiren, and many other existing and extinct fishes.

Osteogeny. The formation or growth of bone.

Osteolite (Gr. ὀστέον, and λίθος, *stone*). An earthy kind of phosphate of lime, probably resulting from the alteration of Apatite, near Hanau, and at Amberg in the Erzgebirge.

Osteology (Gr. ὀστέον, and λόγος). The doctrine or history of the bones. [Anatomy.]

Osteology. In Painting and Sculpture, a description of the bones of animals.

Ostiarius (Lat.). A slave stationed at the door of an ancient Roman house to answer enquiries, like the modern French *concierge*.

Ostraceans. The family of Bivalves of which the oyster (*Ostrea*) is the type; and which is characterised by the mantle being widely open, without special orifices.

Ostracion (Gr. ὄστρακον, *a shell*). A genus of fishes of the *Sclerodermi*, or rough-skinned, in the system of Cuvier. It is characterised by the armour of regular bony plates, soldered together, with which the body is invested; the only movable parts being the tail, fins, mouth, and a small gill-flap, which pass, as it were, through holes in the coat of mail. The body generally presents a quadrangular form, whence the name of *trunk-fish*, commonly given to the species of this genus.

Ostracism (Gr. ὀστρακισμός). A form of condemnation at Athens, by which persons who from their wealth or influence were considered dangerous to the state were banished for ten years, with leave to enjoy their estates and return after that period. It was inflicted not as a punishment, but merely as a precautionary measure to preserve the democracy. The process in this condemnation was as follows: The people being assembled, each man wrote the name of the person whom he wished to banish on a shell (ὄστρακον), and delivered it to the archons, who counted the numbers. Only one citizen could be subjected to the ostracism at the same meeting, and 6,000 hostile votes were necessary for the infliction of this condemnation. Hence if 6,000 votes and upwards were recorded against one or more persons, that one was banished against whom the greatest number of votes had been given. (*Mém. de l'Acad. des Inscr.* vol. xvi.; Grote's *History of Greece*, part ii. ch. xi.) [Petalism.]

Ostracodes (Gr. ὀστρακώδης, *like potsherds*). The name of a family of Entomostracans, comprehending those which have the shell folded in two, so as to resemble the shell of a bivalve mollusc.

Ostranite. A greyish or clove-brown Zircon found at Fredericksvärn, in Norway; and named after the goddess Ostara.

Ostrich (Fr. autruche, Lat. struthio, Gr. στρουθός). The largest known bird, and the type of the Cursorial or Struthious order. It is distinguished not only from its immediate congeners the *Cassowaries*, *Rheæ*, and *Apteryx*, but from all other birds, by having only two toes, which correspond with the two outermost toes in the rest of the class. The wings are furnished with loose and flexible plumes, which are long enough to increase its speed in running. The elegance of these feathers, arising from their slender stems and the disunited barbs, has occasioned them to be prized in all ages,

and they still constitute a valuable article of commerce. The beak of the ostrich is depressed, of a moderate length, and blunt at the end; the tongue is extremely short; the eye is large, and the lid fringed with short simple feathers like eyelashes. The legs are of prodigious strength, and the tarsi very long. The ostrich has a capacious crop; a strong gizzard; voluminous intestines, with two long cæca, complicated each with a spiral valve, and succeeded by a very long intestinum rectum with internal connivent valves, which latter structure is unique in this class of birds. It is likewise remarkable in this class for its large urinary receptacle. The ostrich abounds in the sandy deserts of Arabia and Africa. It attains the height of seven or eight feet; is gregarious in favourable localities; lays eggs of three pounds' weight, which are incubated by the male principally, and defended courageously. The ostrich feeds on grain, grass, &c., to aid in digesting which many pebbles are taken into the gizzard; so obtuse is its taste, that it will swallow pieces of metal, wood, &c. When pursued, it dashes stones behind it with great violence, and exceeds in swiftness all other terrestrial animals; it is only the comparatively limited power of sustaining its course that enables the mounted Arab to run it down.

Ostrya (Gr. ὀστρύα). A genus of *Corylaceæ*, to which belongs the Hop Hornbeam, *O. vulgaris*, a large spreading tree of Southern Europe, which has an ornamental appearance when clothed in autumn with its pendent hop-like catkins. *O. virginica*, the North American species, yields an excessively hard wood called Ironwood.

Otalgia (Gr. from οὖς, *the ear*, and ἄλγος, *pain*). The ear-ache.

Otaria (Gr. οὖς). The name of the genus of seals characterised by having projecting external ears, and by the double cutting edge of the four middle upper incisors, a structure unknown in other animals: the molar teeth are simply conical, and with a single fang. These seals are principally confined to the southern hemisphere.

Otitis (Gr. οὖς). Inflammation of any part of the organ of hearing.

Otoba Wax. A wax obtained from the fruit of the *Myristica Otoba*, a plant growing in the marshy grounds of the river Amazon.

Ottar or Attar of Roses. The volatile or odorous oil of the rose; it is of a soft buttery consistence, and deposits, when fluid, a crystallisable portion, which is sparingly soluble in alcohol: it is much used as a perfume. The finest ottar of roses is prepared at Ghazeepore in Hindustan and at Shiraz in Persia: 20,000 roses are said to yield otto equal in weight to that of a rupee.

Ottava Rima (Ital. *eighth or octuple rhyme*). An Italian form of versification, consisting of stanzas of two alternate triplets and a couplet at the end; the verses being, in the proper Italian metre, the heroic of eleven syllables. It is the form peculiarly adopted and embellished by the poets termed Romanzieri, from Pulci to Fortiguerra. [ROMANZIERI.] It is a happy metre, in the hands of an able versifier, for the expression of feelings varying from the sublime and pathetic to the humorous: although rather deficient in variety, and possessing too little repose and solemnity for the sustained majesty of epic poetry. It has been adopted by the Germans, who have given to it something of an elegiac turn; and, of late, by English poets, of whom the most distinguished is Lord Byron, who employed it in his *Beppo* and *Don Juan*, works belonging to a mixed cast of poetry, between the serious and the burlesque.

Otter (Ger.; Norse ottr). A quadruped adapted to amphibious habits by its short, strong, flexible, palmated feet, which serve as oars to propel it through the water, and by its long and strong tail, which acts as a powerful rudder, and enables the animal to change its course with great ease and rapidity. The teeth, which consist, in each jaw, of six pointed incisors, two strong and sharp canines, and ten trenchant and cuspidated molars, determine the piscivorous diet and predatory habits of the species. The otter used to be met with in most of the British rivers and lakes; but the increase of population, and the unintermitting hostility which its destruction of the valuable fish in its native streams has called down upon it, have greatly thinned its numbers, and have exterminated it from many of the localities where it was formerly common; so that the otter, as a captive in our menageries, is now regarded with almost the same interest which an exotic species usually excites.

The otter selects for its retreat some convenient excavation, concealed by the overhanging roots of the trees which grow from the banks of rivers, or by some other natural screen. The female goes with young nine weeks, and produces from three to five cubs in March or April. The usual weight of a full-grown male is from twenty to twenty-four pounds. The fur of the otter is remarkably fine and close. It consists of two kinds of hair; the longer and stiffer shining hairs, which are greyish at the base and of a rich brown at the point, concealing an extremely fine and soft fur of a whitish grey colour, brown at the tip. The hair and fur of the under part of the body, the cheeks, and the inner parts of the legs, are of a brownish grey throughout.

The otter is hunted in many parts of England, and especially in Wales, with dogs trained for this kind of sport.

The few species of otter which have been recognised in distant parts of the world do not greatly differ from the *Lutra vulgaris* of Europe. The sea-otter is an animal of larger size, and presents such modifications of its palmated feet, and of its teeth, as to form the type of a distinct subgenus (*Enhydra*), which connects the otter with the seal.

Ottoman. The name of the youngest branch of the great Turkish family. The

Ottoman Turks receive their name from Othman, a chieftain who ruled his tribe from A.D. 1299 to 1326, and the epithet has been given generally to the empire founded by his descendants. (Gibbon's *Roman Empire*, ch. lxiv.)

The name is also applied to a peculiar kind of sofa much in use in Turkey, and which has been imitated both here and on the Continent.

Ottrelite. A hydrated silicate of alumina, and of the protoxides of iron and manganese, which occurs in small shining scales disseminated through clay-slate, at Ottrez in Belgium. It has also been found on Snowdon, and in the Isle of Man.

Oudenodon (a word coined from Gr. οὐδέν, *none*, and ὀδούς, *tooth*). A genus of Cryptodont Reptilia in which the upper jaw developed a thick, smoothly rounded, vertical ridge, projecting from the maxillary, in the position of the alveolus of the tusk in *Ptychognathus* and *Dicynodon*. This ridge is solid, and does not contain the smallest vestige of a germ of a tooth answering to the tusk in Dicynodonts. The rest of the alveolar border of both upper and lower jaws is toothless, as in the Dicynodont reptiles, and probably supported, as in the turtles, a horny beak to subserve the masticatory processes.

Ouistitis. A group of small South American monkeys, classified under the names *Hapale* or *Jacchus*, comprising the marmosets and other allied forms. The term *ouistiti* is usually given to them by French writers; they have been separated by Geoffroy St. Hilaire from the other monkeys under the title of *Arctopitheci*.

Ounce (Lat. uncia). A denomination of weight. In troy weight the ounce is the twelfth part of the pound, and weighs 480 grains. In avoirdupois weight the ounce is the sixteenth part of the pound, and equal to 437½ grains troy. [WEIGHT.]

OUNCE. In Zoology, a species of leopardine *Felis*, distinguished by black spots on a grey ground. It is found in Arabia and Persia.

Ouranography (Gr. οὐρανός, *heaven*, and γράφω, *I describe*). A term frequently used to signify a description of the heavens and the heavenly bodies.

Ourari. A poison used by the natives of Guayana to poison their arrows. It is called also Wourali or Urari poison, and has for its basis the juice of *Strychnos toxifera*.

Ourology or **Ouroscopy** (Gr. οὖρον, *urine*). The judgment of diseases from an examination of the urine.

Ouster (Nor. Fr. originally from Lat. ultra, *beyond*). In Law, dispossession, by the act of a wrongdoer, of land or hereditaments. *Forcible entry and ouster* implies dispossession by violence, against which a summary remedy is given by some statutes.

Outcrop. The Geological name for the intersection of the plane of any bed or stratum with the surface of the earth at any place. The various stratified rocks being almost without exception inclined at an angle more or less considerable to the horizon, they must cut it at some line. This may either form a kind of cliff if the bed is hard, or may be a depression and covered by vegetable soil if soft and decomposable. In the latter case it can only be detected by removing the surface, unless indeed a change in the soil itself is effected by the change in the underlying rock.

Outfall. In Engineering, the point of discharge of waters collected by a system of drainage or sewerage.

Outlawry. In Law, an exclusion from the protection of the law, so that an outlaw cannot bring actions, &c., and his property is forfeited to the crown, although with respect to real property the forfeiture does not in some cases extend beyond his own life. An outlaw is, however, still entitled to the protection of the criminal law. Outlawry may be inflicted as a punishment (in criminal cases) for non-appearance to an indictment, or (in civil cases) for absconding after judgment, leaving the judgment debt unpaid. Certain proclamations are required previously to an outlawry, to insure that the party has notice of the process.

Outlier. The name given to a portion of stratified rock remaining in its place in an isolated position after the part of the rock that once connected it with the main deposit has been removed by denudation. An outlier is thus in advance of the general crop of the stratum to which it belongs.

Outline. In the Fine Arts. [CONTOUR.]

Outpost. In a Military sense, a body of men posted beyond the main guard; so called as being without the bounds or limits of the camp.

Outré (Fr.). In the Fine Arts, anything exaggerated or overstrained.

Outremer (Fr. *ultramarine*). A name by which the finer pulverised portions of lapis lazuli used by painters are known in France.

Outrigger. The Sea term for any projecting spar or piece of timber for extending ropes, sails, or oars, so as to give them a greater base or leverage.

Outside Bearings. This term is applied to the bearings of an engine with an external support on a part of the framework of the engine itself; thus, the shaft of a paddle-wheel is said to have outside bearings when it is carried on supports resting upon the spring beam.

Outsides. In Printing, the two outside quires of a ream of paper, formerly consisting of never more than twenty sheets, all of which were either damaged or torn. They were also called *cassie quires* or *cording quires*. Paper is now sent from the paper maker to the printer without outside quires; this is called *perfect* paper, the ream consisting of 516 sheets. [PAPER.]

Outworks. In Fortification, all works between the enceinte and the glacis.

Ouvarovite. [UWAROWITE.]

Ouvirandra (Polynesian ouvi, *yam*; rano, *water*). An interesting genus of aquatic plants,

the most remarkable species of which, found in the hot streams of Madagascar, is known popularly as the Lattice-leaf or Lace-leaf in consequence of the open network of veins of which the leaf consists. These leaves, which are submerged, and grow on long stalks, appear to consist merely of a skeleton of nerves, the longitudinal nerves being connected by numerous short cross nerves. The flower-stalks support a forked spike of simple sessile white flowers. The fleshy farinaceous roots are an article of food in Madagascar. A few other species from Senegambia and India are referred to the genus.

Ouzel, Water. A small English bird, also termed Dipper; the *Cinclus aquaticus* of authors. The names given to it in all the European languages indicate its habit, although a Passerine bird, of diving through shallow water, and rising again at a considerable distance. Its flight is straight, low, and rapid, and it closely resembles the kingfisher in many of its habits. Many other allied species are known, inhabiting many parts of the Old World.

The name belongs to that large family of words which embraces the several modifications of the roots *ac*, *asc*, as shown in the Latin Aqua, in Axius, and the Celtic and Teutonic Esk, Usk, Ax, Exe (Isca), Oxenford (Isis), Ouze, the verb *ooze*, &c.

Oval (Lat. ovum, *an egg*). The general and popular name for any plane closed curve resembling the transverse section of an egg. The ellipse is the most familiar example. There are, however, ovals of higher order, the most important of which are the ovals of Descartes and Cassini. [CARTESIAN OVALS; CASSINIAN OVALS.] The oval known as the *carpenter's oval* consists of four circular arcs taken from two unequal circles and placed symmetrically so that the opposite arcs are equal, and adjacent ones meet, but do not cut each other.

Ovalbumen. The albumen or white of egg; a term adopted in order to distinguish it from the albumen of the serum of the blood, which may be called *seralbumen*.

Ovaries. In Anatomy, the two organs which contain the female ova.

Ovary (Lat. ovum, *an egg*). In Plants, a hollow case, enclosing the ovules or young seeds. It may contain one or more cells, and ultimately becomes the fruit. It is always situated in the centre of the flower, and, together with the style and stigma, constitutes the female system of the vegetable kingdom. When it is united to, or apparently sunk within the calyx, it is called *inferior*; when separate from it, it is termed *superior*.

Ovation (Lat. ovatio). An inferior kind of triumph, granted to Roman military leaders. The name is derived from ovis, *a sheep*, the animal sacrificed on such occasions instead of bullocks. The first ovation is said to have been celebrated by P. Postumius Tubertus (A.C. 503), some years after the expulsion of the kings. Ovations were granted for various reasons, as when the success was not brilliant enough to justify a triumph; or when the war was not completely ended by it, as in the case of Marcellus (Livy xxvi. 21); or if the enemy were not honourable, as in the servile war with Spartacus, &c.

Overhang. In Architecture. [BATTER.]

Overhung Paddle-wheels. Wheels are so called, when the shaft, upon which the paddle-wheels are keyed, does not run through to a bearing on the spring beam, but is supported by a bracket from the ship's side.

Overlap or **Boxing.** In Shipbuilding, the turned-up fore-end of the keel, so made to obtain a firmer bite on the stem.

Overrun. In Printing, when matter is struck out, and it becomes necessary to rearrange the paragraph or pages so altered, the part is said to be overrun.

Overseers of the Poor. Officers annually appointed in every parish by two justices, under the statute of 43 Elizabeth. Their number, by that statute, is four, three, or two, for each parish, in addition to the churchwardens, who are overseers ex officio. By subsequent statutes, any place maintaining its own poor, whether a parish or not, has overseers, and the appointment of collectors and assistant overseers has been authorised. [POOR LAWS.]

Overshot Wheel. In Mechanics, a water-wheel to which the water is conveyed over the top of the wheel and applied above the axle. In this case the water acts merely by its weight, and not by the impulse of the stream.

Overstory. In Architecture, the same as CLERESTORY.

Overt Act (Fr. ouvert, *open*). In Law, an open or manifest act from which criminality is implied. No indictment for high treason is good unless some *overt act* is alleged in it.

Overture. In Music, an instrumental piece, intended to open or commence an extensive musical work, as an opera or an oratorio.

The word *overture* also signifies a *proposal*; in which sense it is always used in the Presbyterian church to denote the resolutions proposed by presbyteries and synods, and afterwards laid before the General Assembly, either for its sanction or rejection.

Oviduct (Lat. ovum, *an egg*; duco, *I conduct*). The tube which conducts the ovum from the ovary either to the uterus or to an external outlet. In Mammals this part is termed the Fallopian tube, from the circumstance of its having been first described by Fallopius about the year 1560 in the human subject, in which this tube or canal passes from each side of the fundus of the uterus to the ovarium. [FALLOPIAN TUBE.]

Oviferous and **Ovigerous.** In Zoology, certain receptacles, in which the eggs are received after having been excluded from the ordinary formative organs of the ovum, are so called, as the long pouches appended to the hinder part of the body in many of the Entomostracous and Parasitic Crustaceans. The ciliated plates (beneath the tail of the

higher Crustaceans, as the crab and lobster) to which the eggs are attached after having quitted the oviducts, are also called ovigerous.

Oviparous (Lat. ovum; pario, *I produce*). The mode of generation by the exclusion of the germ in the form and condition of an egg, the developement of which takes place out of the body either with or without incubation. Fishes, reptiles, and birds are called Oviparous Vertebrates, although some of both the former classes hatch the egg within the body and bring forth their young alive, as the viper and dog-fish.

Ovipositor (Lat. ovum, and pono, *I place*). In Entomology, the instrument by which an insect conducts its eggs to their appropriate nidus, and often bores a way to it; the same instrument is, in some genera, used as a weapon of offence, when it is called the *aculeus*.

Ovis (Lat. *a sheep*, Gr. ὄις). The name by which Linnæus and Cuvier distinguish the sheep as a genus from the goats and antelopes. The character assigned by Cuvier to the genus *Ovis* is as follows: 'Horns directed backwards, and then inclining spirally more or less forwards; the profile or chanfrein more or less convex, and no beard;' to this may be added an interdigital sebaceous sac on the fore part of each foot. The *Mouflons* or *Musmons* of Africa and Sardinia, from which it is generally believed that our domestic races of sheep are derived, form the species *Ovis ammon* of Linnæus, and *Ovis musimon* of Schreber. The coat of these wild sheep consists of coarse, stiff, long, and nearly straight hairs; but they possess the same character, that of an imbricated surface, which gives to the shorter and finer wool of the domestic races the felting property on which its peculiar utility depends. [Hair.]

Of the domestic animals belonging to Great Britain, sheep are, with the exception perhaps of horses and cattle, by far the most important. They can be reared in situations and upon soils where other animals would not live. They afford a large supply of food, and one of the principal materials of clothing. Wool has long been a staple commodity of this country, and its manufacture employs an immense number of people. 'The skin, dressed, forms different parts of our apparel: and is used for covers of books. The entrails, properly prepared and twisted, serve for strings for various musical instruments. The bones, calcined (like other bones in general), form materials for tests for the refiner. The milk is thicker than that of cows, and consequently yields a greater quantity of butter and cheese; and, in some places, is so rich that it will not produce the cheese without a mixture of water to make it part from the whey. The dung is a remarkably rich manure; insomuch that the folding of sheep is become too useful a branch of husbandry for the farmer to neglect. To conclude, whether we consider the advantages that result from this animal to individuals in particular, or to these kingdoms in general, we may, with Columella, consider this, in one sense, as the first of the domestic quadrupeds. "*Post majores quadrupedes ovilli pecoris secunda ratio est; quæ prima sit si ad utilitatis magnitudinem referas. Nam id præcipue contra frigoris violentiam protegit, corporibusque nostris liberaliora præbet velamina; et etiam elegantium mensas jucundis et numerosis dapibus exornat.*' (*De Re Rustica*, lib. vii. cap. ii.) And, in addition to what Mr. Pennant has so forcibly stated, sheep are particularly deserving the attention of the agriculturist, both from the influence of improvements on the breed, and from their generally affording larger profits than can be obtained from the rearing and feeding of cattle.' (*Statistics of the Brit. Empire*, vol. i. p. 492.)

The principal varieties of the English sheep are the large Lincolnshire, the Dorset breed, the Southdown, and the Cheviot.

The Lincolnshire sheep are of a large size, big-boned, and afford a great quantity of wool, owing to the rich marshes on which they feed; but their flesh is coarser, leaner, and less finely flavoured than that of the smaller breeds.

The Dorset sheep are mostly white-faced; their horns are finely curved, their fleece clear and white; but many of them are without wool upon their bellies; their legs are long and small, and their general form handsome and well-proportioned. This breed is prolific, and is principally esteemed for producing lambs at an earlier period than other varieties. The foreign breeds of sheep are exceedingly numerous; but accurate information respecting their zoological and agricultural characters is not yet afforded to us.

Ovisac (Lat. ovum, *an egg*, and saccus, Gr. σάκκος, *a sack*). The cavity in the ovary which immediately contains the ovum. In Mammals it forms, after the ovum is expelled, the *corpus luteum*.

Ovolo (Ital.). In Architecture, a moulding whose profile is the quadrant of a circle. In Grecian architecture there is a deviation from this precise form; it is most apparent at the upper portion, where it resembles the form of an egg, whence this moulding derives its name. In fact, the Grecian ovolo is a portion of a cycloid.

Ovoviviparous (Lat. ovum, *an egg*; vivus, *alive*; and pario, *I produce*). The mode of generation by the exclusion of a living fœtus more or less extricated from the egg-coverings, which has been developed within the body of the parent without any vascular or placental adhesions between the ovum and the womb. The marsupial animals among the Mammalia, the viper and salamander among reptiles, the blenny and dog-fish among fishes, the *Paludina vivipara* and many bivalves among Mollusca, the scorpion and flesh-fly among insects, the earth-worm, and many of the intestinal worms, are examples of ovoviviparous animals.

Ovule (Lat. ovulum). In Botany, the young or immature seed of a plant.

Ovulum. The name of a genus of Pectinibranchiate Gastropods, characterised by having a shell of an oval form, and with a long and narrow aperture, without furrows or teeth, on

the side of the columella; the spire is concealed, and the two extremities of the aperture are equally prolonged into a canal.

This diminutive is also applied to the ovum of the Mammalia on account of its relatively minute size: it is, however, a true ovum, having all the essential parts, as the germinal spot, germinal membrane, vitellus, vitelline membrane, and chorion. [OVUM.]

Ovum (Lat.; Gr. ᾠόν, *an egg*). In Anatomy, the body formed by the female in which, after impregnation, the developement of the fœtus takes place. It is generally formed in a definite part, called the *ovarium*; but in some of the simplest animals, as the Polypes, the common cellular parenchyme of the body seems to have the unlimited faculty of producing the ova. The essential and apparently first-formed part of an ovum is a minute pellucid cell, called the *germinal vesicle*, which is characterised by an opaque speck or nucleus, called the *germinal spot*. The vesicle is immediately surrounded by a stratum of granules or nucleated cells, which form the *germinal disc*. These parts float in a greater or less quantity of fluid and granules, called the yolk, which is generally of some well-marked colour, as yellow, green, violet, red, through the presence of a minutely diffused oil. The yolk is enclosed in a thin, delicate, structureless coat, called the *vitelline membrane*, and this is finally surrounded by an outer tunic called the *chorion*. Between the chorion and vitelline membrane there is commonly a greater or less quantity of albumen. In the birds, this fluid, which is called the *white*, and the *yolk*, is in great quantity; the chorion is laminated, and the outer layer is combined with earthy salts to give due firmness, and preserve the shape of the egg while subject to the weight of the parent during incubation. Two twisted strings of firm albumen, called *chalazæ*, are continued from each end of the yolk, a little below the poles, and serve to steady and keep uppermost the *cicatricula* or *tread*, formed by the impregnated germinal vesicle and disc. A space intercepted between two of the layers of the chorion, or *membrana putaminis*, at the great end of the egg, contains a small quantity of gas, containing more oxygen than atmospheric air: this space is called the *vesica aërea*. [EGG.]

OVUM. In Architecture. [OVOLO.]

Owenite. A silicate of iron and lime resembling Thuringite or Lievrite, named after Dr. Owen, an American geologist.

Owenites. In Political Philosophy, a name sometimes given to the kind of sect established by Robert Owen of Lanark, who held the principle of community of property. [SOCIALISM.]

Owl. Among the ancients generally the owl was considered as an omen of misfortune or death. As, however, according to Philostratus, the Egyptians represented Athena (Minerva) under the form of an owl, the Athenians looked upon the appearance of this bird as a favourable omen. The owl was the ordinary device of the Athenian coinage. The form *howlet* at once connects the word with the Greek ὀλολύζειν, Lat. ululare, Ger. heulen, &c. [NOCTURNALS; STRIX.]

Owling. In Law, the offence of transporting wool or sheep out of the kingdom. This was formerly criminal, both at common law and under several statutes which were all repealed by 5 Geo. IV. c. 47.

Ox (Ger. ochs, Lat. vacca, Sansc. uksha, the root being probably found in Lat. veho, *to carry*). Synonymous with the generic name Bos; in a more restricted sense the word signifies the castrated male of the domestic variety.

Ox-eye. The vulgar name for *Chrysanthemum Leucanthemum*, and for the genus *Buphthalmum*.

Oxacalcite. Native oxalate of lime. [WHEWELLITE.]

Oxalamide. [OXAMIDE.]

Oxalates. Salts of the oxalic acid.

Oxalic Acid. (C_4O_6, 2HO.) This acid was discovered by Scheele in 1776: it is found in some fruits, in the juice of wood-sorrel (*Oxalis acetosella*) and of common sorrel (*Rumex acetosa*), in the varieties of rhubarb, especially the *Rheum rhaponticum*, or pie-plant, and in several other plants. Certain lichens growing upon calcareous rocks contain half their weight of oxalate of lime. It occasionally occurs in urine, as oxalate of lime. The commercial demands for oxalic acid are supplied from artificial sources. When one part of sugar is mixed with four of nitric acid and two of water, nitric oxide and carbonic acid are evolved; after distilling off the excess of nitric acid, and pouring the residue into a shallow vessel, crystals of oxalic acid are deposited, and on further evaporation of the mother liquor a second crop is obtained. Oxalic acid is now, however, chiefly manufactured from sawdust. It is thus produced at a cheaper rate. When woody fibre is heated to a moderate temperature with caustic potash, the products are ulmic acid and hydrogen. At a higher degree of heat, oxalic acid replaces the ulmic; and at a still higher degree, carbonic acid and hydrogen result. The principle of this new manufacture, therefore, is to heat the woody fibre with alkali, to a degree sufficient to produce oxalic, and neither ulmic nor carbonic acid. The sawdust is mixed with a solution of two equivalents of hydrate of soda and one of hydrate of potash, having a specific gravity of 1·35. Soda alone is found not to answer the purpose. The mixture is heated to about 400° in shallow cast-iron pans for some hours, care being taken to avoid charring. The heat is then cautiously raised, and the result is a residue containing a large quantity of the mixed oxalates of potash and soda. A solution of carbonate of soda passed through the mixed oxalates on a filter, transforms the oxalate of potash to oxalate of soda, the carbonate of potash passing through the filter. The oxalate of soda is converted by lime to oxalate of lime, and this compound is decomposed by an equivalent of sulphuric acid. Oxalic acid remains in the liquid, and after two or three crystal-

lisations is obtained in a pure state in large crystals. Two pounds of sawdust thus yield one pound of oxalic acid.

The ordinary crystals of oxalic acid contain four atoms of water of crystallisation. They are intensely sour, and dissolve in about ten parts of water at 60°, their solubility increasing rapidly with increase of temperature; at 212° they fuse in their water of crystallisation: at a temperature of 100°, they gradually fall into powder, and lose about a third of their weight: after having been thus deprived of four atoms of water, they sublime, when heated to about 320°; and the sublimate contains two atoms of water. When the ordinary crystals are rapidly heated to about 350°, water, carbonic acid, carbonic oxide, and formic acid are the results. Unlike most other vegetable acids, oxalic acid is a powerful irritant poison, and the resemblance of its crystals to those of Epsom salt has given rise to many fatal accidents. The antidotes are chalk or magnesia. The intensity of the acidity of oxalic acid is such, that one part in 200,000 of water reddens litmus.

The insolubility of oxalate of lime renders oxalic acid or oxalate of ammonia a valuable test of the presence of lime and its soluble salts. It produces a white cloud in water, holding traces of carbonate or sulphate of lime in solution.

Oxalidaceæ (Oxalis, one of the genera). A natural order of Exogens belonging to the Geranial alliance, in which they are distinguished by their symmetrical flowers with distinct styles, by their carpels being longer than the torus, and by the abundant albumen of their seeds. They comprise herbs, shrubs, and trees, and are found in all the hotter and temperate parts of the world. Besides OXALIS the most important genus is *Averrhoa*, which contains the fruits called Blimbing and Carambola. Oxalidaceous plants are in general marked by their acidity, which is owing to the presence of oxalic acid.

Oxalis (Gr. ὀξύς, *sharp or sour*). A large genus of plants consisting chiefly of herbs, many of them bulbous, found abundantly in tropical America and in South Africa, as well as scattered in other parts of the world; one or two species occur in Britain. They are typical of the *Oxalidaceæ*, and comprise some species of considerable beauty, though few are of much use. The common native species, *O. acetosella*, or Wood-sorrel, has a pleasant acid taste. *O. crenata* yields tubers something like small potatoes, but too insipid and unproductive to be of much consequence; while *O. Deppei* yields fleshy fusiform roots, which are edible and of good flavour.

Oxalite. Native oxalate of iron. It is of a yellow colour, and is found at Kolosuruk in Bohemia; in Hesse, and at Cape Ipperwash in Upper Canada.

Oxaluric Acid. ($C_6H_3N_2O_7$, HO.) Dumb-bell shaped crystals of this body are sometimes found in urinary deposits. As an ammonia salt, it is formed on heating parabanate of ammonia, a derivative of uric acid.

Oxalyl. (C_2O_2.) A name formerly applied to the hypothetical radical of oxalic acid.

Oxamic Acid. One of the products of the destructive distillation of binoxalate of ammonia. Its composition is represented by the formula $C_4NH_2O_5$, HO.

Oxamide. A white substance produced during the destructive distillation of oxalate of ammonia: hence its name, compounded of *oxalis* and *ammonia*. It is a compound of nitrogen, hydrogen, oxygen, and carbon, in such proportions as to form oxalate of ammonia by the addition of four atoms of water. (Dumas, *Théorie des Amides*, *Chim. App. aux Arts*, v. 84.)

Oxgang. In English Antiquities, a word used to signify as much land as a single ox could *ear* or plough in a season. The *oxgang* was contracted or expanded according to the quality of the land; forty acres constituting the maximum and six the minimum of the measure.

Oxhaverite. A translucent pale-green variety of Apophyllite, found on the calcified wood of Oxhaver springs in Iceland.

Oxide (Gr. ὀξύς). Compounds containing oxygen, but which are not *acid*, have been termed *oxides*. The metallic oxides are a most important class of bodies. To designate the different oxides of one element, we generally use the first syllable of the Greek ordinal numerals, designating the first, second, third, &c. oxides by the terms *protoxide*, *deutoxide*, *tritoxide*, &c.; and when the element is saturated with oxygen (still not acid), it is termed a *peroxide*. Compounds of elements with one atom and a half oxygen, or of two of the element and three oxygen, are generally distinguished by the term *sesquioxides*.

Oxlip. The common name for *Primula elatior*; applied also very frequently to umbellate-flowered varieties of the common Primrose.

Oxycoccus (Gr. ὀξύς, and κόκκος, *a berry*). The genus to which the Cranberry belongs. The common Cranberry, *O. palustris*, is a native plant, of shrubby habit, found in bogs, and producing roundish crimson acid berries, which are esteemed by many persons in tarts and preserves. It is stated that before the bogs of Lincolnshire were drained, the Cranberry was sold in Norwich by cartloads. Large quantities are now imported from Russia. The American Cranberry, *O. macrocarpus*, bears larger berries, but they are not so highly esteemed as the common sort.

Oxygen (Gr. ὀξύς, and γεννάειν, *to generate*). This important element was discovered, in 1774, by Dr. Priestley, who obtained it by heating red oxide of mercury, and called it *dephlogisticated air*. It was termed *empyreal air* by Scheele, and *vital air* by Condorcet. The name *oxygen* was given to it by Lavoisier, from its tendency to form *acid* compounds. It is more abundantly diffused throughout nature than any of the other elementary bodies; it forms eight-ninths of the weight of water, one-fifth of the weight of the atmosphere, and is present (often to the amount of from forty to fifty per cent.) in nearly all the mineral bodies of which

the crust of the globe is composed. Oxygen is a constituent of a large class of acids, of all the alkalies, excepting ammonia, and of the alkaline earths; and it enters largely into the composition of numerous organic substances belonging to the animal and vegetable kingdoms.

Oxygen gas may be procured by heating, in a retort, a mixture of one part of peroxide of manganese, and eight or ten parts of chlorate of potash. The oxygen is derived from the decomposition of the chlorate, which is converted into chloride of potassium ($KO, ClO_5 = KCl + O_6$). It may be collected in the usual way over water or mercury. If it contains traces of chlorine, these may be separated by passing the gas through a wash bottle containing a weak solution of potash. One hundred grains of the chlorate will yield thirty-eight grains, = about 113 cubic inches of oxygen: or one ounce will yield nearly two gallons of the gas. This is in the proportion of about twenty-eight gallons of gas to one pound of the salt.

Oxygen is obtained on the large scale by heating to full redness in a wrought-iron bottle the black oxide of manganese, reduced to a coarse powder. This oxide at a full red heat parts with one-third of its oxygen: three pounds will yield nearly a cubic foot of oxygen.

Among other processes for procuring oxygen, two deserve mention. 1. The first depends on the production and decomposition of the peroxide of barium, which is procured by passing a current of air over baryta heated to low redness in a porcelain tube. When the peroxidation is completed, the current of air is cut off, and the tube heated to full redness; at this higher temperature the peroxide returns to the state of protoxide, or baryta; the excess of oxygen is evolved. This oxygen may be collected, and the baryta being again peroxidised, yields a fresh supply. According to Boussingault, a pound of baryta will thus yield about nine gallons of oxygen gas. This is the only method at present known by which oxygen in the gaseous state can be readily procured from the atmosphere. 2. Oxygen has been obtained by causing the vapour of boiling sulphuric acid to pass through a porcelain tube containing fragments of pumice, and heated to full redness: the products are oxygen, aqueous vapour, and sulphurous acid. The sulphurous acid is removed by a weak solution of soda, through which the gaseous products are passed.

The following are the leading characters of oxygen gas. It is insipid, colourless, inodorous, and permanently elastic. Its specific gravity, compared with air, is as 11 to 10; to hydrogen, as 16 to 1. 100 cubic inches weigh 34·24 grains. Its refractive power, in regard to light, is less than that of any of the gases: compared in this respect with atmospheric air, it is as 0·830 to 1·000. According to Tyndall, it has, in reference to heat, a lower absorbing and radiating power than other gases. Faraday has shown that it is the most magnetic of all gases, its magnetic force compared with that of the atmosphere being as 17·5 to 3·4, so that it occupies, among gases, the place which iron holds among metals, and, as with iron, its magnetic force is destroyed by a high temperature; but returns on cooling. The magnetic properties of the atmosphere are almost exclusively due to the oxygen contained in it, and Faraday has suggested that the diurnal variations of the needle may be referable to the increase or decrease of the magnetic force in the oxygen of the atmosphere as the result of solar heat. [MAGNETISM.] Oxygen is evolved by electrolytic action at the positive electrode or anode, and occupies a high position among electro-negative bodies or anions.

Oxygen is dissolved by water, but only in small proportion. At 60°, 100 cubic inches of water dissolve 3 cubic inches of the gas; and at 32°, about 4 cubic inches. All terrestrial waters hold it dissolved, and in this condition it is fitted for the respiration of fish; the blood of these animals, in circulating through the gills, being aërated by the oxygen dissolved in the water. Oxygen is a neutral gas: it does not alter the colour of blue or red litmus. It is an eminent supporter of combustion, and everything burns in it much more vigorously than in common air. Many of its compounds are acid, many alkaline, and many neutral. To the latter the term *oxide* is distinctively applied; and where a base unites with more than one atomic equivalent of oxygen, the respective compounds are conveniently distinguished by a Latin or Greek numeral prefix—thus we have protoxides, deutoxides or binoxides, tritoxides or teroxides, indicating combinations of one atom of base with one, two, and three atoms of oxygen. The highest oxide is frequently termed the peroxide; and when an intermediate proportion of combined oxygen is to be expressed, as where two atoms of an element are united to three of oxygen, the term sesquioxide is used. In the acid compounds, the different proportions of oxygen are generally announced by the terminations *ous* and *ic* applied to the basic body; thus we have sulphurous and phosphorous, and sulphuric and phosphoric acids; and in some cases the oxides are similarly distinguished, as when we speak of nitrous and nitric oxide. When two atoms of a base are united to one atom of oxygen, the combination is distinguished as a suboxide or dioxide: two atoms of copper and one of oxygen form the suboxide or dioxide of copper, &c.

The atomic equivalent, or combining weight of oxygen, is usually taken as = 8, in reference to hydrogen as = 1; and if the volume-equivalent of hydrogen be also assumed as = 1, then the volume-equivalent of oxygen will be = 0·5, inasmuch as water is composed of 1 volume of hydrogen, and ½ a volume of oxygen, or by *weight*, as 1 to 8; the equivalent or atomic weight of water thus becomes = 9. But by those who adopt Gerhardt's notation, this equivalent of oxygen is doubled. [NOTATION, CHEMICAL.]

Oxygenated Water. A name formerly applied to the binoxide of hydrogen, but now restricted to the solution of oxygen gas in water.

Oxyhydrogen Blowpipe. When a mixture of one volume of oxygen and two of hydrogen is burnt whilst issuing from a small aperture, it produces intense heat; and instruments under the above name have been contrived for the combustion of these gases so as to avoid the risk of explosion.

Oxymel (Gr. ὀξύς, and μέλι, *honey*). A mixture of honey and vinegar. It is sometimes made the vehicle of medicines, as oxymel of squills, &c.

Oxymoron (Gr. ὀξύμωρον, *pointedly foolish*). In Rhetoric, a figure, the force of which lies in the paradoxical epithet attached to the subject of the proposition, as *insaniens sapientia* (mad wisdom).

Oxymuriatic Acid. This name was originally applied to chlorine, under the idea that it consisted of muriatic acid and oxygen. The fallacy of that opinion was first demonstrated by Davy, who showed that, in all the apparent cases of the evolution of oxygen from chlorine, its source was referable to the presence of water or of an oxide. Chlorine frequently possesses a stronger attraction for metals than oxygen; so that, when metallic oxides are exposed to its action, the chlorine combines with the metal to form a chloride (formerly called a *muriate*), and the oxygen is evolved.

Oxyopia (Gr. ὀξυωπία). Preternaturally acute vision.

Oxyuri (Gr. ὀξύς, and οὐρά, *a tail*). The name of a family of Pupivorous Hymenopterans, comprehending those which have a sort of tail, or terminal appendage, produced by an external ovipositor or borer. A genus of intestinal worms (Cœlelminthans) is also called *Oxyurus*.

Oyer (Nor. Fr. oyer, Lat. audire, *to hear*). In Law, when an action was brought on a bond or other specialty, the defendant previously to pleading in bar might formerly crave oyer of the instrument on which the action was brought, i. e. to have it read to him; whereupon it was entered verbatim on the record. Other means of compelling the production of documents having been established, oyer was abolished by the Common Law Procedure Act 1852.

Oyer and Terminer (Fr.). In Law, a commission directed to the judges, and others, by virtue of which they have power, as the terms imply, *to hear and determine* all treasons, felonies, and misdemeanours committed within a county. This is one of the four commissions under which the assizes are held in the different counties, the others being the commissions of the peace, of general gaol delivery, and of nisi prius.

Oyez (plur. imperative of oyer). 'Hear ye.' The cry of ushers in Norman courts of justice, still used by public criers, &c. in England, though metamorphosed into 'O yes.'

Oyster (Lat. ostrea, Gr. ὄστρεον, *an oyster*). This name is generally understood to signify the species of Ostracean bivalve called *Ostrea edulis*, which is one of a numerous genus, characterised by an inequivalve shell, composed of two irregular lamellated valves, of which the convex or under one adheres to rocks, piles, or the shell of another individual. The animal is unprovided with either a byssus or a foot; it is the best flavoured of its class, and has, consequently, been always much esteemed. Vast beds of oysters are artificially formed, and attended to with great care, at the estuary of the Thames and many other localities, where the temperature of the water is somewhat raised by a mixture of salt and fresh water, in which they best thrive. Certain restrictions and regulations are enforced in reference to the sale of oysters in the metropolis, in order to favour the multiplication and rearing of this valuable bivalve. They are permitted to be sold from August to May, the close months being May, June, and July. They cast their spat or spawn in May, when they are said to be sick; but begin to recover in June and July, and in August they are perfectly well. Oysters differ in quality, according to the different nature of the soil or bed. The best British oysters are found at Purfleet; the worst near Liverpool. The nursing and feeding of oysters is almost exclusively carried on at Colchester and other places in Essex. The oysters are brought from the coast of Hampshire, Dorset, and other maritime counties, even as far as Scotland, and laid on beds or layings in creeks along the shore, where they grow, in two or three years, to a considerable size, and have their flavour improved. There are said to be about 200 vessels, from 12 to 40 or 50 tons burden, immediately employed in dredging for oysters, having from 400 to 500 men and boys attached to them. The quantity of oysters bred and taken in Essex, and consumed mostly in London, is supposed to amount to 14,000 or 15,000 bushels a year. (Supplement to *Ency. Brit.* art. 'Fisheries.') Oysters formed a great luxury among the Romans, and, as in France, were served at the commencement of a repast. The largest and best oysters of Italy were caught on the shores of the Lucrine; but the Roman markets also received supplies from this country, the British oysters being then, as now, in the highest estimation.

Oyster Catcher or **Sea-pie** (*Himantopus ostralegus*). A small Grallatorial bird, allied to the plover, has been so named from its habit of opening the shells of bivalve mollusca with its powerful bill. It makes no nest. It is indigenous in the northern portion of the Old World, from Ireland to Japan.

Oyster Green. A name given to *Ulva Lactuca*, from the circumstance that its bright green fronds grow frequently on the shell of the oyster.

Oyster Plant. A popular name for the native *Steenhammaria maritima*, the leaves of which have a flavour resembling that of oysters.

Ozæna (Gr. ὄζαινα, from ὄζω, *I smell*). An ulcer in the nose which discharges a fetid purulent matter, and is sometimes symptomatic of caries of the bones.

Ozarkite. An amorphous or fibrous kind

of Thomsonite, from the Ozark Mountains, Arkansas.

Ozokerite (Gr. *ὄζειν, to smell*, and *κηρός, wax*). A mineral resin, resembling a resinous wax in consistence and translucence. It occurs in amorphous masses, sometimes fibrous or foliated, and is of a yellowish-brown colour by transmitted light, and dark leek-green by reflected light. It has an agreeable aromatic odour, softens by the heat of the hand, and may be kneaded like wax. It is found in Urpeth Colliery, near Newcastle-on-Tyne, and at Uphall in Linlithgowshire. At Slanik and Zietrisika, in Moldavia, it occurs in sufficient quantity to be used for economical purposes.

Ozone (Gr. *ὄζειν*). When electric sparks are passed through air a peculiar odour is produced, sometimes referred to the production of nitric acid, but which, since the researches of Schönbein, in 1840, is now generally ascribed to an allotropic modification of oxygen. In this country the subject attracted little notice, till Faraday, in a lecture at the Royal Institution in June 1851, gave an account of Schönbein's researches, and of the results of his own observations. Since that time much curious information has been obtained upon the subject. The term *ozone* has reference to its odour, which has been described as resembling that of chlorine in a very diluted state, or, more correctly perhaps, that of a stick of phosphorus fuming in the air. Something similar is often smelt in the atmosphere on a frosty morning; and in these cases chemical tests indicate *ozone*, i.e. a peculiar condition of oxygen. This condition may be produced in various ways; the simplest, perhaps, being to place in a bottle of air a stick of *phosphorus* freshly scraped. Sufficient distilled water should be poured into the bottle to partially cover the phosphorus; the vessel should then be closed and kept at a temperature between 60° and 70°. The phosphorus is oxidised in the usual way; and during this oxidation a portion of the oxygen passes to the state of *ozone*, and is diffused through the air of the bottle. A test of its presence is a slip of paper moistened with a solution of starch and iodide of potassium. When ozone is formed, this paper, on immersion, acquires a blue colour, owing to the production of iodide of starch. In a warm room, this evidence of ozone is procured in ten or twelve minutes; but the maximum quantity is found in six or eight hours. Only a small part of the oxygen undergoes this change; and if long kept, the ozone may be lost by combining with and oxidising the phosphorus. Ozone may be produced on a small scale by placing a bit of phosphorus with water in a watch-glass, and inverting over this another glass containing the test-paper.

Ozone is also produced by passing the electric spark through oxygen, and it is formed in the electrolytic decomposition of water.

In 1850, Schönbein found that ozone was a product of the slow combustion of *ether*. If a little ether be poured into a bottle, and a clean glass rod heated to about 500° introduced, vapours are given off, which cause the bluing of iodised paper; and the residuary ether acquires the property of bleaching the blue sulphate of indigo.

In whatever way ozone is produced, its properties are the same. It is insoluble in water, alcohol, and ether. It is dissolved by a solution of an alkaline iodide, converting it into an iodate. It decomposes the protosalts of manganese, producing peroxide. Silver leaf, on which common oxygen has no action, is, when wetted and exposed to ozonised air, oxidised, and the ozone disappears.

Organic substances are variously affected by it. It bleaches most vegetable colours, and seems in all cases to act as an oxidiser. It appears to be a powerful disinfectant.

Ozone is in all cases destroyed by a high temperature, and when heated to about 500° reverts to the state of ordinary oxygen.

Schönbein has distinguished what he considers as a modified condition of ozone, by the term *antozone* (*Philosophical Magazine* 1858), which he suspects to be a constituent of certain peroxides; but further investigations are required for the establishment of his hypothesis. It seems probable that antozone may be *peroxide of hydrogen*.

Ozonometry. This term has been applied to the means of detecting the presence and proportion of ozone in the atmosphere. For this purpose paper or linen, imbued with a mixture of iodide of potassium and starch, is principally used. It may be prepared as follows: One part of *pure* iodide is dissolved in two hundred parts of distilled water; ten parts of starch, finely powdered, are mixed with the solution, and the liquid gently heated until thickened from the solution of the starch. White unsized or sized paper is soaked in the liquid, dried, and cut into slips which may be kept in a stoppered bottle.

When intended for use, a slip of the paper is exposed to a free current of air in a spot sheltered as much as possible from rain, light, and foul effluvia, for a period varying from six to twenty-four hours. A box has been contrived for thus testing the atmosphere by Mr. Lowe. (*Proceedings of the Royal Society*, vol. 10, p. 531.) By exposure, the paper becomes brown, and when wetted acquires shades of colour varying from a pinkish white and iron grey to a blue. A chromatic scale has been contrived by Schönbein, with which the changes in the wetted paper may be compared. Frémy recommends white blotting-paper, soaked in an alcoholic solution of guaiacum, and dried in the dark, as a test for ozone. By exposure to an ozonised atmosphere, this paper acquires a bright blue colour. Houzeau's test is a strip of litmus paper of a wine-red colour, of which one half has been soaked in a solution of iodide of potassium in water, in the proportion of one per cent. As a result of exposure to ozonised air, the iodised portion becomes alkaline, and the paper acquires a deep blue tint. The

other portion preserves its red colour; and by showing an acid or alkaline reaction, may reveal the presence of vapours in the air, which might otherwise be a source of error.

Mr. Lowe observed that the strongest effect was produced during the night, and at some elevation above the ground: also that the months of January, February, and March, gave the largest amount, both day and night. On a number of days there were no visible traces of ozone. Other observers have found it to vary according to locality, the season of the year, the hour of the day, the direction of the wind, and the height of the place above the level of the sea. It is seldom found in closely inhabited spots. In some observations made at Brighton, Mr. Faraday procured evidence of ozone close to the sea-shore, as well as in the air of the open downs; but none in the air of the town. Dr. Angus Smith could not detect ozone in the air of Manchester; but at a distance, it was easily recognisable when the wind was not blowing from the town. It has been objected to this mode of testing, that the change in the iodide may be due to chlorine, nitric, and other acids, or to organic compounds diffused in the atmosphere, and not to ozone. But it is to be observed that the test-paper remains unchanged exactly in those spots where such compounds would be likely to exist (i.e. in inhabited towns); while the chemical effect is observed to be at a maximum on open heaths, or downs, on the sea-coast, and on lofty elevations, where there is no probable source of such impurities. It is possible, too, that nitric acid, even if really existing in the air of those places, may itself be the product of the oxidation of nitrogen by ozone; and this may be the source of nitric acid, often found in rain-water; and even in the atmosphere. The absence of any reaction for 118 days out of 365, and the greater effect by night than by day, in wet than in dry weather, and in winter than in summer, show that these phenomena are not due to the presence of such impurities in the air as those suggested. At the same time, the presence of iodate of potash in the iodide used, may have been a source of error. A discolouration of the paper might then be produced by sulphurous acid and sulphuretted hydrogen.

P

P. A consonant of the labial series. As was to be expected from the approximation of this letter in sound to *b*, it is susceptible of interchange with the latter in nearly all the languages of which we have any knowledge, but more especially in the German. Both in this country and on the Continent there are whole districts in which the ear of the natives is insensible to the difference between the sound of these letters, and in which they are almost invariably confounded in pronunciation. Of this peculiarity several counties of Wales, and the whole of Lower Saxony in Germany, present noted examples. [ABBREVIATION.]

P. In some Medical formulæ P is used as the abbreviation of *pugillus*, the eighth part of a handful.

P. In Music, an abbreviation of PIANO [which see].

P. Æ. The abbreviation of *partes equales*, or equal parts.

Paca (a Brazilian word). A small species of the Linnæan genus *Cavia*, distinguished from its congeners by white spots on a dark ground.

Pace (Fr. pas). A denomination of linear measure of uncertain extent; assumed by some to be 5 feet, by others 4·4 feet. It is the quantity supposed to be measured by the foot from the place where it is taken up to that where it is set down. The ancient Roman pace, considered as the thousandth part of a mile, was five Roman feet, and each foot contained between 11·60 and 11·64 modern English inches; hence the pace was about 58·1 English inches, and the Roman mile, the *mille passus*, equal to 1,614 yards. [MILE.]

Paces, Military. [MARCH.]

Pacha. [PASHA.]

Pachacamac. The name given by the idolaters of Peru to the being whom they worshipped as the creator of the universe. In the fruitful valley of Pachacama (whence the name) the incas dedicated to his honour a temple of such wealth, that, notwithstanding the rapacity of the Spanish soldiers, by whom it was plundered before the arrival of Pizarro, that general is said to have drawn from it treasures to the amount of 900,000 ducats.

Pachira (derivation uncertain). A magnificent genus of tropical plants, belonging to the order *Sterculiaceæ*, better known under the name of *Carolinea*, given them in compliment to the Princess Sophia Caroline, of Baden. They are trees, with digitate leaves, and showy flowers. *P. alba* is, according to Mr. Purdie, one of the most useful plants of New Grenada, its inner bark furnishing the whole country with strong cordage. *P. Barrigon* also affords a useful fibre, and its seeds are used to stuff pillows, cushions, &c. Some of them, as *P. Fendleri*, yield a useful timber.

Pachnolite (Gr. πάχνη, *rime*, and λίθος, *stone*). A fluoride of aluminium, calcium, and sodium, occurring in shining, transparent colourless crystals in the Cryolite of Greenland.

Pachydermata (Gr. παχύς, *thick*; δέρμα, *skin*). An order of quadrupeds, including the elephant, rhinoceros, horse, pig, &c., distinguished by the thickness of their hides.

Pachyglossates (Gr. παχύς, and γλῶσσα, *a tongue*). The name of a family of parrots (*Psittacini*), comprehending those which have a thick protractile tongue.

Pachyotes (Gr. παχύς, and οὖς, *an ear*). The name of a family of bats (*Cheiroptera*), including those which have thick external ears.

Pachyrhizus (Gr. παχύῤῥιζος, from παχύς, *thick*, and ῥίζα, *a root*). The name of a tropical genus of *Leguminosæ*, one of the species of which, *P. angulatus*, produces great fleshy roots, which are eaten. The roots grow in a horizontal direction underground, and are often six or eight feet long, and as thick as a man's thigh. They are of a dirty white colour, and insipid when cooked, but are used as food in times of scarcity. The twining stems yield a tough fibre, which the Feejeans employ in the construction of fishing nets. The plant extends over the tropics of both hemispheres.

Pacific Ocean. This vast tract of open water occupies an area of not less than ninety millions of square miles (excluding the Indian Ocean), very thinly dotted with comparatively small islands except in the Indian Archipelago. Its limits are the Arctic and Antarctic Oceans, the whole western coast of the Americas, the eastern coast of Asia as far as the Malayan peninsula, the islands of the Indian Archipelago, numerous coral reefs, and the north-eastern and eastern coasts of Australia. In some parts it is very deep, but its bottom has not been so systematically surveyed as that of the Atlantic. Its coast line is very much smaller than that of the Atlantic, although its area is much larger. The drainage into it is also comparatively small. Except on the Asiatic coast, there are few extensive bays, gulfs, or inland seas connected with it. Its eastern side is free of islands, but the west is entirely fringed by detached land.

The general form of the Pacific is that of a wide open natural basin; and were it not for the long series of tropical islands stretching nearly half-way to America from New Guinea, and connected by numerous coral reefs, there would be hardly any interruption or break observable. It is, no doubt, a consequence of this absence of land, that the winds are so much more regular and less subject to violent disturbance on it than on other seas, and that the name of *Pacific* has become applicable.

The currents in the Pacific are less considerable in magnitude and force than in the Atlantic, and the winds and tides are more regular, as well as smaller and less remarkable. The shores enclosing this ocean are, however, high and rocky; and, so far as America is concerned, they rise immediately into very lofty mountains.

The bed of the Pacific, or at least that part of it between the tropics, and most especially the part in the tropic of Capricorn, is subject to great and systematic depression, as is proved by the innumerable coral reefs and islands of coral met with almost throughout. Where not subject to depression, much of it seems to be exposed to the action of elevatory forces, so that a large section of this part of the world is in active movement. By far the most remarkable lines of volcanic action on the globe belong to this ocean, one of them commencing in the islands of the Indian Archipelago, and extending eastwards into the Pacific, and the other, equally remarkable, ranging from the north-west coast of North America to the Straits of Magelhaens and Cape Horn.

The oceanic warmth equator crosses the earth's equator near the middle of the Pacific, and remains much nearer that latitude than is the case with the oceanic warmth equator of the Atlantic.

Pacification, Edicts of. The term usually applied to the edicts issued by the French monarchs in favour of their Protestant subjects, in the view of allaying the commotions occasioned by previous persecutions. The first edict of this nature was promulgated by Charles IX. in 1562; but the most celebrated was the EDICT OF NANTES, issued by Henry IV. in 1598, and revoked by Louis XIV. in 1685.

Pacinian Corpuscles. Small oval bodies situated on some of the cerebro-spinal and sympathetic nerves, especially the cutaneous nerves of the hands and feet, are so called, after their discoverer, Pacini.

Packet. In Navigation, this word meant originally a vessel appointed by government to carry the mails between the mother country and foreign countries or her own dependencies. It is now used as nearly synonymous with an ordinary vessel (chiefly of small burden), that freights goods or passengers.

Packfong. The Chinese name of an alloy of nickel and copper resembling *German silver.* It consists of 7 parts of zinc, 2·5 copper, and 6·5 nickel.

Pacos. The Peruvian name of an earthy-looking ore, which consists of brown oxide of iron, with particles of native silver disseminated through it.

Padding. In Calico-printing, the impregnation of the cloth with a mordant.

Padding Machine. An apparatus used by calico-printers for uniformly imbuing a piece of cotton cloth with any mordant.

Paddle (Fr. patrouiller, indicating the moving of water by the *foot*; Lat. pes; Gr. ποῦς, ποδός). A kind of oar or flat spoon used by savage nations in navigating their canoes. The paddle is broader at the end than the common oar, and may have a blade at one or both ends. In the former case the blade is dipped alternately on either side of the canoe: in the latter, less motion is required—first one blade and then the other being plunged in the water. The paddle has this advantage over the oar, that the rower faces his destination; but it is a weaker propeller, as the rower's arm and back have to conduct the force to the boat, a service performed for the oar by the fixed rowlock. [SCULLING.]

Paddles. [STEAM NAVIGATION.]

The timber of *Aspidosperma excelsum*, a strong light elastic wood obtained in Guiana.

Paddock (A.-Sax. pearroc, *park*: Wedgwood). This term was formerly applied to a strip of ground in a park, paled round, for hounds to run matches in; but at present it is chiefly used to denote a small enclosure under pasture, immediately adjoining the stables of a domain, for turning in a sick horse, or a mare and foal, or for any similar purpose.

Paddy. Rice in the unhusked condition. A paddy-field is a field of growing rice.

Padisha. A title of the Turkish sultan and Persian shah. Formerly the Turkish emperor conferred this title upon the kings of France alone among the European sovereigns, but we believe that the honour is now likewise shared by the emperors of Austria and Russia. [PASHA.]

Paduan Coins. In the Fine Arts, coins forged by the celebrated Paduans, Cavino and Bassiano, who were also the artists employed on the pope's medals, from Julius III. to Gregory XIII. (1571). These coins hold the first rank in imitations of ancient medals for their masterly execution. M. Beauvais says of them, 'that they are seldom thinner than the ancient coins themselves; that they seldom appear as worn or damaged, whilst others very frequently do, especially in the reverse, which sometimes, as in many Othos, appears half consumed by time; and while counterfeit medals are very commonly of as irregular a form as the real, those of the Paduan masters are generally circular.' Still more modern forgers have been content to mould their dies from the productions of these Paduan engravers; but these are cast coins, which it requires no very extraordinary knowledge to detect. The marks of the file upon their edges are mostly a sure sign of the imposition; those, however, who collect these objects of art should be constantly on their guard.

Pæan (Gr. Παιάν). Among the Greeks, properly a hymn in honour of Apollo, who was also called Pæan. Also a war song before or after battle: in the first case in honour of ARÊS, in the second as a thanksgiving to Apollo.

PÆAN. In Ancient Poetry, a foot consisting of four syllables, of which there are four kinds; the Pæan primus, secundus, &c. [FOOT.]

Pædobaptists (Gr. παῖς, *a child*, and βαπτίζω, *I baptise*). Those who hold that baptism should be administered during infancy. The great majority of Christian churches which allow the baptism of infants are thus denominated from that circumstance, and are thereby distinguished from the Antipædobaptists, i.e. those who deny the validity of infant baptism. [BAPTISTS.]

Pæonia. A fine genus of *Ranunculaceæ*, very popular in gardens on account of their large, varied, and richly coloured flowers, which in the double-blossomed varieties resemble huge double roses. The subshrubby species from China and Japan, commonly called *Tree Pæonies*, are sometimes referred to a distinct genus, *Moutan*. The fleshy roots of *P. albiflora* are sometimes boiled, and eaten in broth by the natives of Northern Asia. The plants are known by producing many-seeded follicles, and by bearing their stamens on a glandular disc.

Pagan (Lat. paganus, from pagus, *a village*). Among the Romans, this name was applied to all who lived in villages, in contradistinction to the inhabitants of cities. In its present signification it is the opposite of *Christian*, being synonymous with *heathen*, *gentile*, and *idolater*; and was originally so applied because the inhabitants of villages remained idolaters after Christianity had been introduced into towns and cities. The precise period when the term *pagan* was first used in its present acceptation has not been ascertained. [HEATHEN.]

Paganalia (Lat.). The annual festival of the Roman Pagani, or inhabitants of the Pagi, or districts, which are said to have been instituted by Servius Tullius. Each country tribe was divided into a certain number of these districts, which existed to the latest times of the empire, and which had each its own presiding magistrate and its own religious rites.

Paganism. A general appellation for the religious worship of the whole human race, except of that portion which has embraced Christianity, Judaism, or Mohammedanism.

In its origin, paganism, as a system, was simple. [MONOTHEISM; MYTHOLOGY; POLYTHEISM.] It may, however, be doubted whether the mythological systems of the Greeks and Romans were to any great or even to any extent the results of a deification of human heroes. Such, in the rationalism of later philosophers, was the favourite hypothesis of those who were perplexed at the strange qualities and adventures attributed to many of the gods, and this method of interpretation was carried to its extreme point by Euêmerus. (Grote's *History of Greece*, part i. ch. xvi.) But the science of comparative philology has shown that Phœbus, Apollo, Hercules, Phaethon, Orpheus, the Charites (or Graces), &c. are themselves mere names, and that some of them occur as mere names in the Vedic poems. It is obvious that the expressions in which such names would occur in their original sense would assume a very different character when translated into the conditions of human life. If the Sanscrit *Dyaus* (the heaven) loved the earth, which everywhere answered to that love, this in the mythology of Homer would be converted into the various loves of Zeus (or Jupiter). Thus mythical phrases, beautiful and innocent at the first, might give birth to myths whose immorality repelled the later poets and philosophers of Greece. (Max Müller's *Comparative Mythology*.)

Page (Mod. Lat. pagius, a word of uncertain derivation; according to some, from pagus, *village*). In high life, a youth attached to the service of a royal or noble personage. In the ancient Persian court (which has been

termed the archetype of all courts), we find the usage of employing a number of youths of the noblest families of the empire in personal attendance on the sovereign. Among the Greeks and Romans (to whom monarchical institutions, strictly so called, were unknown), no analogous custom appears to have prevailed. Among the northern nations, on the other hand, personal service of this sort was common. The name *pages*, however, appears confined to slaves and attendants of an inferior class, in modern Europe, until the reigns of Charles VI. and Charles VII. of France. (Fauchet's *Origine des Chevaliers.*) As chivalric institutions prevailed, the office, by whatever name it may be called, became of importance. Courts and castles were the schools in which the young noble passed through the degree of page, in order to reach the higher grades of esquire and knight, when he became hors de page. In the sixteenth century the chivalrous character had become much adulterated; but the custom of bringing up sons as pages at courts continued until the disorder and license of the age rendered the service so dangerous that it was no longer sought by the better classes as a mode of education for their children. Pages then became, as they are now, mere relics of feudal custom: from some courts they have entirely disappeared; and the young noblemen of the cadet school perform the office of pages on solemn occasions. In the Queen's Household there are a certain number, with the titles of *state pages*, *pages of the presence*, &c.

PAGE. In Printing, one side of the leaf of a book. A folio volume contains 4 pages in every sheet, a quarto 8, an octavo 16, a duodecimo 24, an octodecimo (18mo.) 36 pages, &c.

Pageant. In its general sense, a public representation or exhibition of a showy and splendid character. It was a very early custom in the middle ages, both in England and on the Continent, to celebrate festive occasions of a public nature, as royal visits, marriages, &c., by some ornamental show in the public streets of cities. During the period of chivalry these shows began to be exhibited with the addition of masked figures representing allegorical personages, with appropriate scenery; and as, in process of time, speeches in verse or prose were put into the mouths of these figures, and sometimes a kind of dramatic entertainment performed between them, the pageant consequently holds a place in our early literature. The earliest speaking pageant of which we have any account was presented on the triumphal entry of Henry VI. into London, in 1432; and the poetical part of it is conjectured to have been supplied by Lydgate. The reign of Henry VIII. was fertile in pageants of an extraordinary magnificence and splendour. In the reign of Queen Elizabeth they assumed a different form, and were both devised and enacted with much more elegance: partly from the tincture of romantic gallantry which distinguished the court of the maiden queen, and was perceptible in all the homage rendered to her by her subjects, and partly from the sudden developement of the poetical genius of the nation. The pageants gradually became more dramatic, and thus approximated more nearly to the character of the MASQUE, which, under her successor, became the fashionable court entertainment. Pageants, however, were still presented by the city of London, which retained a poet laureate of its own for the purpose of inditing the spoken part of them, down to the year 1700, or thereabouts; and the lord mayor's procession still exhibits some characteristics of these ancient entertainments. The derivation of this word is wholly unknown, and has afforded much scope to the fancy of etymologists.

Pagina (Lat.). In Botany, the surface of a leaf.

Pagoda. In Architecture, a name for a Hindu temple containing an idol. Sometimes it signifies the idol itself. The pagoda is generally of three subdivisions: first, an apartment whose ceiling is a dome resting on columns of stone or marble—this part is open to all persons; second, an apartment forbidden to all but brahmins; third and last, the cell which contains the statue of the deity, enclosed with a massive gate.

PAGODA. The name of a gold coin, value from 8*s.* to 9*s.*, current in several parts of India. It is also the name of a silver coin of the same value, on which are stamped images of the Hindu gods.

Pagodite. A mineralogical synonym of AGALMATOLITE.

Paguridæ (Lat. pagurus, Gr. πάγουρος, *a hermit-crab*). The name of a tribe of Macrurous Decapod Crustaceans, of which the genus *Pagurus* is the type. Most of the species of this family inhabit, parasitically, the deserted shells of univalves.

Paigle. One of the rustic names for the Cowslip, *Primula veris*, chiefly used in the eastern counties.

Painim. A poetical expression used by English writers for *pagan*.

Pains and Penalties, Bill of. A species of process employed to inflict punishment on state offenders out of the ordinary course of justice. Every bill brought into parliament for the purpose of inflicting such punishment is a bill of pains and penalties, of which bills of attainder [ATTAINDER] are, properly speaking, a species; but the term is more commonly confined to bills introduced to inflict specified penalties for particular acts. The latest instance of this extraordinary proceeding was the bill of pains and penalties against Queen Caroline (1820), introduced into the House of Lords, and passed by them, but not carried into the Commons.

Painter. In Naval language, a rope used to fasten a boat to any other object.

Painter's Colic. [COLIC.]

Painting (Fr. peinture). In strict definition, painting is an art which, by means of light, shade, and colour, represents on a plane surface all objects presented to the eye or to

the imagination. The word (γράφειν) used to express painting among the Greeks, being the same as that employed for writing, indicates the tools with which drawing was performed among that people, viz. the *graphis*, a style or pen of wood or metal, used on a levigated plane of wood, metal, or some other prepared ground; the mode, letters or lines. Until its operations become founded on the faithful representations of visible objects of nature, undisfigured by mannerism and modification from the fashion and habits of a country (such, for instance, as we meet with in the Indian, Egyptian, and Chinese representations of the human form), it is scarcely entitled to the appellation of fine art; hence, dismissing with few remarks its appearance in those countries where traces of it in that condition are to be found, we shall speak chiefly of that æsthetic developement, simplicity of end, and uniformity of pursuit, which enabled the ancient Greeks, the great arbiters of form, to carry it to a degree of excellence which no subsequent age or nation has been able to surpass.

Goguet, in his *Origine des Loix*, says that the first essay of the art of writing, using the expression in its most general sense, was by means of the representation of corporeal objects: such as the Egyptian hieroglyphics. The earliest people, he says, naturally used this method for exhibiting their thoughts, and commenced by representing to the eye the objects they wished to impress on the mind. The origin, however, of painting, properly so called, involved as it is in the greatest obscurity, presents one of the most difficult questions in the history of the arts; and opinions are very much divided as to the country that gave birth to it. Pliny says, that the Egyptians boasted of being acquainted with the art six thousand years before the Greeks; but his words are, 'Affirmant, vana prædicatione, ut palam est.' The specimens of Egyptian paintings now extant exhibit a collection of conventional representations of human and other figures which indicate extremely slender advances in the æsthetic element of the art. They are mostly rudely drawn: no notion of perspective or grouping, as we understand it, nor sentiment, appears in any of their productions, though the Egyptians show considerable practical skill, and occasionally great freedom of handling. Their resources in colours were very great; they are commonly mixed with glue size. The Greeks got their colours from the Egyptians. Tyre and Sidon were celebrated for their artists; Paris, it is said, took Sidonian girls with him to Troy, there to work their many-coloured embroideries. This embroidery, *pictura textilis*, is the only kind of painting noticed in the Homeric poems.

The art of painting in China seems to have remained the same from time immemorial. It has never exceeded the bounds of imitation, and even in that respect it is devoid of taste and truth. The human figure with the Chinese is a distorted misrepresentation, and their perspective is attained by piling one object on the top of another till the picture is all earth and no sky. Invention and imagination were never known among them; and though they are in many respects ingenious in manipulation, their dexterity is exhausted in painting the fins of a fish or the petals of a plant.

Etruscan art is known to almost every person by the vases that bear that name, and of which there is an extensive and interesting collection in the British Museum; but they are mostly of pure Greek manufacture. Though the history of this nation is involved in obscurity, sufficient information has reached us to demonstrate the height of perfection to which they carried the fine arts. About twelve miles from the town of Civita Vecchia stood the ancient Etruscan city of Tarquinii; near which are found a considerable number of sepulchral grottoes, some of them decorated with paintings and figures much in the style of those on the Etruscan vases. Some of the pictures represent combats, and in others the subjects are dances of females, all executed with considerable spirit. (Micali, *Monumenti degli Antichi Popoli Italiani*, Flor. 1832–44; Dennis's *Cities and Cemeteries of Etruria*, Lond. 1848.) Their pottery, however, appears to afford the greatest number of specimens in the arts of design; the forms displayed in the contours of the vases, no less than the paintings with which they are decorated, evince wonderful elegance in design, with purity of form, and ingenuity in its delineation. Their power over line and their facility of execution may be easily conceived from the absorbent nature of the material upon which they wrought. No retouching was possible; but the whole must have been completely arranged in the mind before it could be struck off by the artist. Pliny (xxxv. 6) states that in his day the town of Ardea, an ancient city of Etruria, contained in the temple of Juno some paintings, which he ascribes to a period anterior to the time of Tarquinius Priscus, and mentions with surprise their then perfect state of preservation. At Lanuvium, also, he describes a naked group of Atalanta and Helen, which were simply painted on the wall, and exhibited great merit in execution. These Caligula, after a fruitless attempt, failed in removing. Cære, another Etruscan city, possessed some paintings of an early date.

In the following remarks on Greek painting, Fuseli's first *Lecture* has been freely made use of; for full details of the subject, the reader is referred to the article 'Painting' in the *Dict. of Greek and Roman Antiquities*, Lond. 1842, and Wornum's *Epochs of Painting*, Lond. 1864.

The vocabulary of the technical expressions, *nature*, *beauty*, *grace*, *taste*, *copy*, *imitation*, *genius*, and *talent*, is explained as follows: By *nature* is meant the general and permanent principles of visible objects, neither disfigured by accident nor distempered by disease, neither modified by fashion nor local habits. *Beauty* is that harmonious whole of the human frame, that unison of parts to one end, which enchants us. It is the result of the standard set by the

great masters of the art, the ancients, and confirmed by modern imitation. *Grace* is an artless balance of motion and repose, springing from character, founded on propriety, and neither falling short of the demands nor overleaping the modesty of nature. Applied to execution, it is that dexterous power which hides the means by which it is attained. By *taste* is meant not crudely the knowledge of what is right in art, but an estimation of the degrees of excellence by comparison, proceeding from justness to refinement. *Copy*, though generally confounded with *imitation*, is essentially different in operation and meaning. Precision of eye and obedience of hand are the requisites of the former, without pretence to choice or selection; whereas choice, directed by judgment or taste, is the essence of imitation. 'Of *genius* I shall speak with reserve,' says Fuseli; 'for no word has been more indiscriminately confounded;' by genius is meant the power which enlarges the circle of human knowledge, which discovers new materials of nature, or combines the known with novelty; whilst *talent* arranges, cultivates, and polishes the discoveries of genius.

Religion was the motive of Greek art; it was therefore natural that they should endeavour to invest their own authors, for they considered themselves of divine origin, with the most perfect form; and as man alone possessed that form, they completely and intellectually studied his elements and constitution. A climate favourable to the developement of that constitution, and the establishment of exercises by their civil and political institutions, created models in nature which raised Greek art to the highest excellence.

Skiagrams, or simple shaded outlines such as we see on the earlier vases, similar to those known under the name of *silhouettes*, were the first essays of the art. They had no addition of character or feature but what the profile of the object thus delineated could afford. 'Greek art had her infancy; but the Graces rocked the cradle, and Love taught her to speak. If ever legend deserved our belief, the amourous tale of the Corinthian maid, who traced the shade of her departing lover by the secret lamp, appeals to our sympathy to grant it.'

Both the plastic and graphic arts owe their origin, according to this romantic legend, to the same source. The daughter of Dibutades, a potter of Sicyon, settled at Corinth, struck with the shadow of her lover cast by her lamp on the wall, drew its outline, and with such precision that her father cut away the plaster within the outline, and took an impression from the wall in clay, which he baked with the rest of his pottery. The legend adds that this singular terracotta was still preserved at Corinth until the destruction of the city by Mummius, 146 B.C. This simple first form or skiagram (σκιαγράφημα) was also when in colour essentially a monochrome (μονοχρώματον).

The next step of the art was the *monogram* (μονόγραμμον), i.e. the outline of figures without light or shade, with the addition, however, of parts within the figure, such, for instance, as the outlines of Flaxman. It was invented by Philocles of Egypt or Cleanthes of Corinth; but the first who acquired reputation by this kind of art were Ardices of Corinth and Telephanes of Sicyon. From this to the *monochrome*, or painting of a single colour with light and shade, at first apparently on a white ground, generally of a red, sometimes of a dark brown or black colour, was the next advance. The first eminent colourist of this class was Cleophantus of Corinth. The next step was the superinduction of different colours, or the invention of the *polychrome*, which, by the addition of the pencil to the style, raised the stained drawing to a legitimate picture. Hygiemon, Dinias, and Charmadas are mentioned by Pliny as having been famous monochromists. It is, of course, only in the polychrome that we have the real developement of the art of painting, the art of representing natural objects in a natural manner, the ζωγραφία of the Greeks. Eumarus of Athens and Cimon of Cleonæ were among the earliest pioneers of the art, the latter being spoken of as the inventor of foreshortenings—*catagrapha*.

Polygnotus is the first great name that appears on record at a period when some satisfactory history of the art might be commenced. He flourished about 460 years B.C. So great was his success in the Pœcile at Athens, and the Lesche or public hall of the temple of Apollo at Delphi, that, in a general council of the Amphictyons, it was solemnly decreed that his expenses, whenever he travelled in Greece, should be borne at the public charge. From the description of his pictures by Pausanias, it would seem that composition in painting, as we now understand that term, was not at all understood, inasmuch as that author begins his description at one end of the picture and finishes at the opposite extremity, which indicates pretty plainly that there could be no central group or figure to which the rest were subordinate. Aristotle (*Poetica*, ii. ii.) says that Polygnotus improved his model; and if we consider the variety of powers by which the parts of his pictures were distinguished, it would be unfair to say that the primitive arrangement just mentioned arose from want of comprehension in the artist. The separate groups illustrated different subjects, and constituted probably several pictures. The style of Polygnotus may, like that of Phidias, be called generic. The subjects of his great works at Delphi were the *Destruction of Troy* and the *Descent of Odysseus* (Ulysses) *to Hades*, and were known as the Iliad and Odyssey of Polygnotus. Two German painters, the brothers Riepenhausen, have attempted the revival of these celebrated compositions. (*Peintures de Polygnote à Delphes dessinées et gravées d'après la Description de Pausanias.*)

The principal contemporaries of Polygnotus were Dionysius of Colophon, a portrait painter; Micon of Athens, an excellent horse painter;

and Panænus of Athens, the nephew of Phidias, whom he assisted in the decorations of the throne of the Olympian Jupiter.

After these, about 420 B.C., came Apollodorus the Athenian. 'This painter,' says Fuseli, 'applied the essential principles of Polygnotus to the delineation of the species, by investigating the leading forms that discriminate the various classes of human qualities and passions. The acuteness of his taste led him to discover, that as all men were connected by one general form, so they were separated each by some predominant power which fixed character and bound them to a class.' Pliny and Plutarch considered Apollodorus as the first colourist of his age. It is probable from their descriptions that he was the inventor of local colour and tone, which received from the former the term *splendor*. He seems to have been a kind of Rembrandt in effect; he was called the *Shadower*. Zeuxis of Heraclea, in Macedonia, succeeded to Apollodorus, and, by uniting in one figure the most perfect parts of many models, produced an ideal form (his *Helen of Croton*), which, in his opinion, constituted the supreme degree of human beauty. Lucian describes a picture he exhibited at the Olympic games as remarkable for its invention; it was the representation of a female Centaur suckling her young, and the account is to be found in the memoir inscribed with the name of Zeuxis.

Parrhasius, a native of Ephesus, but a citizen of Athens, was the son and disciple of Evenor, and contemporary of Zeuxis. By his subtle examination of outline, he established that standard of divine and heroic form which raised him to the authority of a legislator from whose decisions there was no appeal. That he was a thorough master of allegory, is evident from his embodying by signs, universally understood, the Athenian people (ΔΗΜΟΣ), in which he expressed at once its contradictory qualities. 'Perhaps,' observes Fuseli, 'he traced the jarring branches to their source, the aboriginal moral principle of the Athenian character, which he made intuitive. This supposition alone can shed a dawn of possibility on what else appears impossible.' In his competition with Timanthes the Cythnian, or, as some say, of Sicyon, he had the mortification to be declared by a majority of votes inferior to him. The subject of the competition in which he was thus defeated was the contest of Ajax and Ulysses for the arms of Achilles.

Parrhasius is said to have combined the *tone* of Apollodorus with the fine *form* of Zeuxis, and the classic invention and expression of Polygnotus; but he was, says Pliny, the most insolent and arrogant of artists.

No picture of antiquity has acquired so much celebrity as the sacrifice of Iphigenia in Aulis by Timanthes. Quintilian informs us that it was painted in contest with Colotes of Teos, an artist from the school of Phidias, and crowned with victory at its rival exhibition. This picture, which has been the subject of the unlimited praise of critics of antiquity, has, in modern times, been the subject of criticism, from the circumstance of Timanthes hiding the face of the father (Agamemnon) of the victim in his mantle, as being unable by his art to express the intensity and agony of his grief. Upon this Sir Joshua Reynolds observes in his Eighth Discourse, 'If difficulties overcome make a great part of the merit of art, difficulties evaded can deserve but little commendation.' The French critic, Falconet, has not been less unsparing than the English president in his condemnation of the artifice. The answer of Fuseli to these critics appears to us satisfactory. He says, 'The subject of Timanthes was the immolation of Iphigenia. Iphigenia was the principal figure; and her form, her resignation, or her anguish, was the painter's principal task: the figure of Agamemnon, however important, is merely accessory, and no more necessary to make the subject a completely tragic one than that of Clytemnestra, the mother; no more than that of Priam, to impress us with sympathy at the death of Polyxena.' Again, 'They ascribe to impotence what was the forbearance of judgment. Timanthes felt like a father; he did not hide the face of Agamemnon because it was beyond the power of his art—not because it was beyond the possibility, but because it was beyond the dignity of expression; because the inspiring feature of paternal affection at that moment, and the action which of necessity must have accompanied it, would either have destroyed the grandeur of the character and the solemnity of the scene, or subjected the painter with the majority of his judges to the imputation of insensibility.' The same expedient to express grief was adopted by Michael Angelo in the figure of Abijam, and by Raphael in the *Expulsion from Paradise*, borrowed from Masaccio. These were the artists who formed the second school of art, and established its end and limits. On it was founded the third period of style, the Alexandrian, in which refinement induced a grace and beauty to forms not to be surpassed. It was the last stage of progression and acquisition, and was characterised by refinement of execution and individuality of representation. This appears to have been chiefly brought about by Eupompus of Sicyon: and his authority was so great that out of the Asiatic and Grecian schools of painting he formed a third, by dividing the last into the Attic and the Sicyonian. When consulted by Lysippus (Pliny l. xxxv.) on a standard of imitation in art, he pointed to the crowd passing by; observing that nature, not an artist, should be the object of imitation. Pamphilus, a Macedonian, the master of Apelles, and the most scientific artist of his day, adopted the doctrines of Eupompus. To the art of painting he joined the study of mathematics, and held the opinion that without the aid of geometry no painter could ever arrive at perfection. This period is rich in great names, all distinguished for some special quality. Pamphilus of Amphipolis and his pupil Melanthius were remarkable for their effective com-

position; Apelles of Cos or of Colophon for grace or *beauty*; Protogenes of Caunus for elaborate execution; Pausias of Sicyon and Nicias of Athens excelled in light and shade of various kinds — the latter in his youth had been a painter of statues (an ἀγαλμάτων ἐγκαυστής); Euphranor the Isthmian was distinguished for his universal excellence, or perhaps what may be termed Academic precision; Nicomachus of Thebes for boldness of execution; Aristides his brother for intensity of expression; Theon of Samos for his prolific fancy; Athenion of Maronea for accuracy and severity of style, especially in colour; besides others of less note, as Philoxenus of Eretria, a battle painter, Asclepiodorus of Athens, and Echion. In Apelles, we are told by Pliny, unrivalled excellence was found. Grace was his powerful and peculiar faculty, in which, and in knowing where to stop, he surpassed all that preceded him, and left not his equal in the world. The story of the lines or sketches which were drawn by himself and Protogenes at Rhodes, in competition with each other, is not a legendary tale, but a well attested fact. Aristides of Thebes, and contemporary of Apelles, was the first who, by the rules of art, attained a perfect knowledge of expressing the passions and affections of the mind. The history we have of the picture which Alexander, at the sacking of Thebes, sent to Pella, proves his power of infusing the passions into his works. In it were expressed the anguish of maternal affection and the pangs of death. Euphranor, the pupil of Aristides, is said to have carried still further the refinements of that expression so powerful in the hands of his master. Skilled in sculpture as well as painting, his conceptions were noble and elevated, his style masculine and bold; and he was the first who distinguished himself by imparting majesty to his heroes. Asclepiodorus, the Athenian sculptor as well as painter, was, as the latter, celebrated for the beauties of a correct style and the truth of his proportions. Apelles allowed himself to be, in these respects, as much inferior to this artist, as he was to Amphion in the good ordering and disposition of his figures.

In Rome, also, a taste for painting was rapidly spread after the conquests of Greece and Sicily, but the artists were for many generations almost exclusively Greeks. Rome was, however, always more distinguished for its collections than for its artists, who, of whatever country, were for the most part portrait painters and decorators. The Roman collectors, like those of Egypt, gave extravagant prices for ancient pictures; and some masterpieces, even in this early time, were destroyed by inexpert picture cleaners. For a long period after the reigns of Vespasian and his son Titus, painting as well as sculpture continued to flourish in Italy. Even under their successors, Domitian, Nerva, and Trajan, they met with as much encouragement as in the most palmy state of the arts in Greece. Under Hadrian, the Antonines, Alexander Severus, Constantine, and Valentinian, the art of painting continued to be an object of interest; but at length, in the reign of Phocas, with the fall of the empire, it was involved, like the rest of the noble arts and sciences, in the common ruin brought about by the invasions of northern barbarians.

Greek painting, however, was not only sacrificed to the lust of Roman conquest; its decay was hastened by inherent vices, by pandering to depraved and vulgar tastes. The Greeks had their caricaturists and their *genre* painters. Some men, such as Pyreicus, and Antiphilus, an Egyptian, acquired great names for their pictures of the ordinary scenes and incidents of low life. The greatest blow, however, experienced by the imitative arts of antiquity, was from the change of religion and the establishment of Christianity. The losses caused by the early Christian iconoclasts were overwhelming; even the inroads of barbarians and the decay involved by age together can have done but little injury compared with the wilful destructions of a blind religious fanaticism.

The Greeks painted in *tempera* and in encaustic: apparently never in fresco. The *tempera* or distemper was much the same as the modern *guazzo*, or that practised by the early Italian painters, egg and fig sap being the chief vehicles. In encaustic painting, the colours were mixed with a little resin and wax, and the picture was afterwards heated or *burnt in* by means of a *cauterium* or hot iron: some celebrated masters were distinguished in one method, some in another. There are many remains of ancient painting at Pompeii and elsewhere, generally showing great facility of execution, but, in all decorative work, an extraordinary disregard or want of appreciation of perspective. Among the finest examples of ancient compositions, are the large mosaic of the battle of Issus in the Casa del Fauno, at Pompeii, discovered in 1831; and the painting of the so-called Aldobrandini marriage, discovered on the Esquiline early in the seventeenth century, and long preserved in the Aldobrandini Villa, but since 1818 in the Vatican, where it was placed by Pius VII., who purchased it of the Aldobrandini family for 2,000 guineas. Of the numerous works on ancient painting, the following are important: Bartoli, *Recueil de Peintures Antiques, imitées fidèlement pour les Couleurs et pour le Trait*, &c. Paris 1757, folio; R. Rochette, *Peintures Antiques*, or *Recherches sur l'Emploi de la Peinture &c.* Paris 1836, 4to.; Letronne, *Lettres d'un Antiquaire à un Artiste*, Paris 1840, 8vo.; Zahn, *Die schönsten Ornamente und Merkwürdigsten Gemäelde aus Pompeii &c.* Berlin 1828—ff, folio; John, *Maler i der Alten*, Berlin 1836, 8vo.; and Rosellini, *Monumenti dell' Egitto e della Nubia &c.* Pisa 1832-44, folio.

Painting in Italy owes the dawn of its restoration to the immigration of Byzantine Greek painters after the Venetian capture of Constantinople in 1204. But these painters and their scholars adhered to the mediæval

conventionalities, according to the Byzantine practice, until Giovanni Cimabue of Florence (1240-1302), by attempting to paint from nature and as large as life, caused a revolution in taste which established a revival of the art. Examples of the mediæval and of the revived art may be seen almost in juxtaposition in the National Gallery, in the two pictures by Margaritone of Arezzo and Cimabue. The latter, though without the art of managing his lights and shadows, and but slenderly acquainted with the rules of perspective, nevertheless laid so firm a foundation for the future improvement of the art, as to entitle him to the name of the father of the first age of modern painting. Giotto, his pupil, originally a shepherd boy, born near Florence in 1276, was a much more able painter than his master. He divested himself of the shackles in which the system of the Greek art of that age had bound his master, adding somewhat of grace to his figures and nature to his colouring. Of a picture which he painted in the church D'Ogni Santi at Florence, representing the death of the Virgin with the Apostles about her, Vasari related that Michael Angelo used to say that the truth could not be nearer approached than in it. He was the friend of Dante and Petrarch, and painted the portrait of the former. On his decease, in 1336, the city of Florence erected his statue in marble over his tomb in the cathedral. There is a good example of his work in the National Gallery.

Among the earlier painters of merit of this time may also be mentioned: Giunta Pisano, employed at Assisi; Taddeo Gaddi, Giotto's favourite pupil; Andrea Orcagna, also a distinguished architect, who designed the celebrated Loggia dei Lanzi in the Piazza Granduca at Florence; Jacopo di Casentino; Spinello Aretino; Simone Memmi of Siena (1284-1344), and Pietro Cavallini, of the Umbrian School. Painters were now so numerous that they began to form trade guilds, called companies of St. Luke, who was almost invariably adopted as their patron, from the old church tradition that that evangelist was a painter. All these early artists were *tempera* painters; neither fresco nor oil-painting were yet known. Pietro d'Orvieto is supposed to have executed the first example of pure or *buon fresco*, in the Campo Santo at Pisa in 1390. *Oil* or rather *varnish* painting was first discovered by the brothers Hubert and John Van Eyck, about 1410, at Bruges, and was not introduced into Italy until fifty years later, when it was carried from Flanders to Venice by Antonello of Messina (1414-96), who had learnt the method of Bruges, apparently of a third brother, Lambert Van Eyck. Hubert died in 1426 at Ghent, aged sixty; John died at Bruges in 1440, aged about fifty. The art advanced, though but slowly, gathering little strength till the appearance of Masaccio. 'Sculpture had already produced respectable specimens of its reviving powers in the bassi-rilievi of Lorenzo Ghiberti, some works of Donatello, and the Christ of Philippo Brunelleschi, when the first symptoms of imitation appeared in the frescoes of Tommaso da San Giovanni, commonly called Masaccio, from the total neglect of his appearance and person. Masaccio first conceived that parts are to constitute a whole; that composition ought to have a centre, expression truth, and execution unity: his line deserves attention, though his subjects led him not to investigation of form; and the shortness of his life forbade his extending those elements which Raphael, nearly a century afterwards, carried to perfection.' Masaccio was born in 1402, and continued the series of frescoes commenced by his master Masolino da Panicale, in the Brancacci chapel at Florence, where he was engaged about 1425-27, when he paid a visit to Rome, and there died, it was supposed by poison, either in 1428 or 1429. Frà Filippo Lippi and his son Filippino are distinguished for delicacy of execution. Equal progress was in the meanwhile made in the sentiment of art by Frà Giovanni da Fiesole, known as the Beato Angelico (1387-1455). Antonio Pollojuolo of Florence (1430-1496) advanced to a still higher degree the excellence of execution, especially in *tempera*. He was the first to dissect the dead subject for purposes of art. Both masters are seen to advantage in the National Gallery. Andrea Mantegna, born near Padua in 1431, was a disciple of Jacopo Squarcione. Though he was correct in his drawing, well versed in perspective, and apparently acquainted with the antique, albeit the best antique statues had not then come to light, his neglect of certain refinements induced a crudeness of taste. He died in 1506, having been the first who practised the art of engraving in Italy. Bono of Ferrara, also a pupil of Squarcione, known as Bono Ferrarese, Mantegna's contemporary, was also an excellent master, and painted in a similar style. In this place we must not forget the master of so great a man as Leonardo da Vinci, Andrea Verocchio, a Florentine (1432-88). He was well skilled in geometry, optics, music, architecture, sculpture, and painting; the last of which he is said to have abandoned, because, in a picture whereon he was engaged of the baptism of our Saviour, his pupil, Leonardo, had, under his order, painted in an angel, holding up some part of our Saviour's garment, so far excelling Andrea's own figures, that, enraged at being outdone by a youth, he resolved never again to wield the pencil. It is said he was the first who preserved individual likeness by moulding the face in plaster of Paris. Leonardo da Vinci, of noble descent, and born about 1452 in a castle so named near Florence, surpassed all his predecessors. His powers seem to have been unlimited: he was an admirable sculptor and architect, a skilful musician, an excellent poet, expert in anatomy and chemistry, and well versed in all parts of the mathematics. Rubens had a very high opinion of his works, and especially of his Cenacolo, in the refectory of the Dominicans at Milan. He was many

years director of an academy of painting at Milan, which city he much benefited by his contrivance of the canal that supplies it with water from the river Adda. His death took place at Cloux near Amboise, in France, in 1519: the story of his dying in the arms of Francis I. has proved to be a fiction. The last master of this period was Frà Bartolomeo della Porta. Though not endowed with the comprehension of Leonardo, he gave gradation to colour, form and masses to drapery, and dignity to execution. Frà Bartolomeo was a native of Savignano, near Florence, and was born in 1469. Nudities were, from scruples of conscience, scarcely ever represented by him, though he was a perfect master of drawing the human figure. He was the first who used the lay figure. Fuseli says of him, 'He was the true master of Raphael, whom his tuition weaned from the meanness of Pietro Perugino, and prepared for the mighty style of Michael Angelo Buonarotti.' Frà Bartolomeo died in his convent of St. Mark, in 1517. Of the Umbrian painters, the great master was Pietro Vannucci, called Il Perugino, born at Città della Pieve in 1546. He died a citizen of Perugia, at Castello di Fontignano in 1524. He and Francesco Raibolini of Bologna (1450–1517), commonly called Francia, were the first great Italian oil-painters; masterpieces of both may be seen in our own National Gallery.

The greatest of the Florentines was Michael Angelo Buonarotti, born at Castel Caprese, near Arezzo, March 6, 1475. He studied painting with Domenico Ghirlandajo, but first distinguished himself as a sculptor. His great frescoes of the Sistine Chapel at Rome were painted in 1509–12 and 1533–41. In 1547 he was made architect of St. Peter's, and carried out the building to the base of the cupola; he died at Rome on February 17, 1564, and on March 14 following was buried in a vault of the church of Santa Croce at Florencce.

'Sublimity of conception,' says Fuseli, 'grandeur of form, and breadth of manner, are the elements of Michael Angelo's style. By these principles, he selected or rejected the objects of imitation. As painter, as sculptor, as architect, he attempted, and, above any other man, succeeded, to unite magnificence of plan, and endless variety of subordinate parts, with the utmost simplicity and breadth. His line is uniformly grand; character and beauty were admitted only as far as they could be made subservient to grandeur. The child, the female, meanness, deformity, were by him indiscriminately stamped with grandeur. A beggar rose from his hand the patriarch of poverty; the hump of his dwarf is impressed with dignity: his women are moulds of generation; his infants teem with the man; his men are a race of giants.' Again, 'He is the inventor of epic painting, in that sublime circle of the Sistine Chapel, which exhibits the origin, the progress, and the final dispensations of theocracy.' His principal disciples or followers were Marcello Venusti, Il Rosso, Giorgio Vasari, and Frà Sebastiano del Piombo. Raphael Santi of Urbino was born on April 6, 1483, and died on April 6 (Good Friday), 1520. The grace and mild genius of Raphael were, perhaps, much more capable of exciting our sympathies than the burst of inspiration which the works of the last-named master universally exhibited. As Michael Angelo was the father of epic painting, so was Raphael the father of dramatic painting. 'If separately taken,' says Fuseli, 'the line of Raphael has been excelled in correctness, elegance, and energy; his colours far surpassed in tone, and truth, and harmony; his masses in roundness, and his chiaro-oscuro in effect: considered as instruments of pathos, his pictures have never been equalled; and in composition, invention, expression, and the power of telling a story, he has never been approached.' Giulio Romano, architect and painter, was his greatest pupil. His style was drier and harder than any of Raphael's school, and he was frequently harsh and ungrateful, though generally vigorous and often grand. He died of fever at Mantua on November 1, 1546, in his forty-eighth year.

Giorgio del Castel Franco, called (from his size and beauty) Giorgione, and Tiziano Vecelli, combined with form the alluring and fascinating charm of colour. Born in the Venetian States, and in the same year (1477), they laid the foundation of the Venetian school. Giorgione died young in 1511. Titian survived, to carry out their principles, to the unusual age of ninety-nine; he died of the plague in 1576. Giovanni Bellini, the master of Titian (1426–1516), was a good painter of portraits and of Madonnas, and an excellent colourist, as were also his contemporaries and rivals Giambattista Cima da Conegliano and Marco Basaiti. Other good painters of the north of Italy of this time were, Vittore Carpaccio, Paolo Morando, Bonsignori, and Girolamo dai Libri; by all of whom there are fine works in the National Gallery. Paolo Cagliari, commonly called Paul Veronese (1528–1588), developed the splendour of the Venetian school to the utmost magnificence. Jacopo Robusti, called Tintoretto (1512–1594), a great master, but too often careless, professed to combine the colouring of Titian with the drawing of Michael Angelo. Of Titian, Fuseli says, 'He invented that breadth of local tint which no imitation has attained, and first expressed the negative nature of shade: his are the charms of glazing and the mystery of reflexes, by which he detached, rounded, connected, or enriched his objects.' 'He is the father of portrait painting, of resemblance with form, character with dignity, and costume with subordination.' Antonio Lieti or Allegri, called Correggio, from the place of his birth, in the duchy of Modena, completed the charms of colouring and chiaro-oscuro. His chief works are at Modena and Parma: at which last place he passed the greater portion of his life. He died at Correggio of a fever, at the early age of forty, on March 5, 1534. Though the power of

Correggio's colouring was great, still greater was that of his chiaro-oscuro. The merits of Raphael are pathos and character; the power of Titian was his colour, and that of Correggio his harmony. We have not space to dwell on the genius of Pordinone, who disputed the superiority of Titian, the meagre style of Andrea Vannucchi, surnamed Del Sarto, or the extraordinary vigour but puerile imbecility of conception of Pellegrino Tibaldi; but we must not pass without notice the name of Sebastiano del Piombo, a Venetian, who died at Rome, at the age of sixty-one, in 1547. His name Del Piombo is derived from his office of keeper of the leaden seals given him by Pope Clement VII. Here he so ingratiated himself with Michael Angelo, by joining the party against Raphael, that he was assisted in his designs by that great master, and especially in the *Raising of Lazarus* now in the National Gallery, which gained the universal applause of Rome, and was even put on a par with the celebrated picture of the *Transfiguration* by Raphael, but Michael Angelo had no hand in the painting of it. Equally favoured by Michael Angelo was Daniele Ricciarelli of Volterra, who died at Rome in 1566 in his fifty-seventh year; he was a sculptor as well as painter. The depravation of the style of Michael Angelo which now generally supervened is sufficiently visible in the works of Giorgio Vasari, born at Arezzo in 1512, to whom the world is more indebted for the labours of his pen, in the *History of the Lives of the most celebrated Painters, Sculptors, and Architects*, first published at Florence in 1550, than for those of his pencil: he died at Florence, June 27, 1574.

'Vasari,' says Fuseli, 'overwhelmed the palaces of the Medici and of the popes, the convents and churches of Italy, with a deluge of mediocrity. Francesco Primaticcio, of Bologna, the scholar of Giulio Romano, made abbot and superintendent of the royal buildings of St. Martin de Troyes by Francis I., studied and spread the style of his master in France, where he decorated the palaces of that king with mythology and allegory, in which he was assisted by his pupil, Nicolò dell' Abate, and Il Rosso or Maître Roux, a Florentine. He was the founder of the so-called school of Fontainebleau, out of which the French school of painting arose. Primaticcio died wealthy at Paris in 1570, aged sixty-six. Francesco Mazzuoli, called from Parma, the place of his birth, Parmegiano, was an imitator of Correggio in tone and colour, and of Michael Angelo in form; he was born in 1504, and died at the early age of thirty-six. 'That disengaged play of delicate forms,' says Fuseli, 'the *sveltezza* of the Italians, is the prerogative of Parmegiano, though nearly always obtained at the expense of proportion.'

Towards the end of the sixteenth century, Lodovico Carracci (1555-1619), with his cousins Annibale and Agostino, founded a school at Bologna, in which it was proposed to select the beauties, correct the faults, supply the defects, and avoid the extremes of the different styles, and so attempt to form a perfect system. The recipe of ingredients for the formation of a perfect painter are contained in a sonnet by Agostino, well known to artists; they are as follows: Roman design, Venetian motion and shade, Lombardy's dignified tone of colour, the fierce style of Michael Angelo, Raphael's symmetry, Titian's truth to nature, and Correggio's sovereign purity: add to these the decorum and solidity of Tibaldi, the learned invention of Primaticcio, and a little of Parmegiano's grace; or, to save all this trouble, imitate the works of Nicolò dell' Abate. This was empiricism unworthy of such men as the Carracci, whose talents were of a very high order; but this was the beginning of the so-called eclecticism which distinguished the art of the seventeenth century, and gradually deteriorated into a species of academic materialism. Agostino (1559–1601), with a singular modesty, which prompted him rather to propagate the fame of others by his graver, than by steady exertion to rely on his own power for perpetuity of name, was the most learned of the Carracci, and a good colourist. Annibale, whose taste was unequal to both of these, though his power of execution was far superior, was born at Bologna, in 1560, and was the disciple of his cousin Lodovico. His great work was the painting of the Farnese Palace, in which, whilst we admire the vigour of the execution, we cannot help lamenting the choice of subject, which, says Fuseli, is 'a chaotic series of trite fable and bacchanalian revelry, without allegory, void of allusion, merely to gratify the puerile ostentation of dauntless execution and academic vigour.' Such was the veneration of Annibale Carracci for the genius of Raphael, that his deathbed request was to be buried in the same tomb with him (the request was complied with), in the Pantheon at Rome, 1609. This eclectic Bolognese school did not last long: its scholars soon followed each his own peculiar taste. Its principal masters were Bartolomeo Schedone (1580–1615), Guido Reni (1575–1642), Lanfranco, Albani, Domenichino, and Guercino. Schedone embraced and often applied the harmony and colour of Correggio; whilst Giovanni Lanfranco (1581–1647) strove to follow him through the expanse of his creation and masses, more especially in his great schemes of foreshortened groups.

'Grace,' says Fuseli, 'attracted Guido, but it was the studied grace of theatres; his female forms are abstracts of antique beauty, attended by languishing attitudes, and arrayed by voluptuous fashions. His male forms, transcripts of models found in a genial climate, are sometimes characteristic of dignified manhood or apostolic fervour, sometimes stately, courteous, insipid.' Francesco Albani (1578–1660) formed Nereids on plump Venetian models, and contrasted their pearly hues with the rosy tints of Loves, the juicy brown of fauns and satyrs, of rich marine or sylvan scenery. Domenico

Zampieri, called Domenichino (1581–1641), whose great qualities, through the jealousy of rivals, doomed him to a miserable life, aimed at the beauty of the antique, the expression of Raphael, the vigour of Annibale Carracci, the colour of Lodovico; and, mixing something of each, fell short of all; whilst Gio. Francesco Barbieri, called Il Guercino da Cento (1592–1666), broke through all academic rules, sacrificing mind, form, and costume to effects of colour, fierceness of chiaro-oscuro, and intrepidity of hand.

Guercino, like most of the Bolognese of this epoch, had at one time been fascinated by the vigorous manner of Michael Angelo da Caravaggio (1569–1609), the founder of the school of the so-called *Tenebrosi*. He was distinguished for the unparalleled force of his shadows, but he was also at times an excellent colourist. The master who most nearly approached, and sometimes even surpassed, him, was Giuseppe Ribera, called Lo Spagnoletto (1588–1656), the most successful of the infamous triumvirate of Naples, which was so intolerant of rivals as to use the foulest means to get rid of them: Domenichino is said to have been one of the many victims to this cabal.

From this time the art declined rapidly in Italy. It was, indeed, held up for a short period by the exertions of Nicolas Poussin, born at Andely, in Normandy, in 1594: he went early to Rome, and studied in the academy of Domenichino there. He adopted Rome for his country, and studied the works of antiquity with such zeal, that, like Polidoro da Caravaggio, he acquired a habit of thinking in their way. Many of his works have the effect of coloured ancient bassi-rilievi. Poussin died at Rome in 1665. Pietro da Cortona and Luca Giordano possessed very considerable talents; but they were much abused in their exercise by implicit obedience to the tasteless commissions of their employers.

Germany, though without much apparent intercourse at this time with Italy, had profited by the progress of the arts; and towards the end of the fifteenth century, we find the works of Albert Dürer had succeeded the rude and uncouth productions of Schaffner, Schön, Wolgemuth, and Altorfer. Albert Dürer was born at Nuremberg on Good Friday, 1471. Although his style was crude and ungraceful, his prints were esteemed throughout Italy, copied at Venice by the celebrated Marc Antonio, and so much admired by even Raphael himself that he decorated his own chamber with them, and lamented that such a man had been educated in a country where the want of models and works of art must have so much retarded his progress. With the single exception of Holbein, no German painter of this period was free from a mannerism in drawing, which was never agreeable, but is often hideous. The knowledge, however, of the state of painting in Italy attracted hosts of German, Dutch, and Flemish students, who, 'though content to feed on the husks of Tuscan design, imbibed the colour of Venice, and spread the elements of that excellence which distinguished the succeeding schools of Flanders and of Holland.' It has been already mentioned, that as oil-painters the Flemish school preceded the Italian. And the great followers of the Van Eycks, at Bruges, surpassed their contemporaries in Italy, not only in the method, but also in delicacy of execution. The elder Vander Weyden, who died in 1464, and Memling, who died in 1495, both visited Italy: also Dierick Bouts, Hugo Vander Goes, Gerard Vander Meire, the younger Vander Weyden, Quintin Matsys, Bernard van Orley, Lucas of Leyden, and Jan de Mabuse, were all masters of this school distinguished for their rich colouring and remarkable delicacy of execution.

Peter Paul Rubens, born at Siegen, in Westphalia, in 1577, and Rembrandt van Rhyn, born at Leyden in 1607, by their extraordinary powers again showed that Italy was not the only spot in which art could take root, but that Flanders and Holland afforded a soil in which it could flourish. The former of these, bred at Antwerp under the instruction of Otho van Veen, had, previous to his journey to Italy, acquired an unbounded power over the instruments of his art, and on his arrival was the successful competitor for fame with those masters whom he selected as objects of emulation. Venice was the centre of attraction for him; and there, from the splendour of Paul Veronese, and the glow of Tintoretto, he compounded 'that florid system of mannered magnificence which is the element of his art, and the principle of his school.' He died in 1640. His scholars saw through the eye of their master instead of seeing through that of nature; but from this censure must be excluded the illustrious name of Vandyck (1599–1641) and that of Abraham Diepenbeck. Of the portraits of Vandyck no mention is here necessary to enhance the esteem in which they are held. 'The fancy of Diepenbeck, though not so exuberant, excelled in sublimity the imagination of Rubens; his Bellerophon, Hippolytus, Ixion, Sisyphus, fear no competitor among the productions of his master.' Rembrandt, except in what relates to form, was a genius of the highest order. 'In spite of the most portentous deformity, and without considering the spell of his chiaro-oscuro, such were his powers of nature, such the grandeur, pathos, or simplicity of his composition, from the most elevated or extensive arrangement to the meanest and most homely, that the best cultivated eye, the purest sensibility, and the most refined taste dwell on them equally enthralled.' He died at Amsterdam in 1669.

The most celebrated of Rembrandt's scholars were Gerard Dow, Gerbrand Vanden Eeckhout, Ferdinand Bol, Govert Flink, Philip de Koning, and S. van Hoogstraten. M. Miercvolt, Frank Hals, and B. Vander Helst, were his contemporaries, and his rivals as portrait painters, though they worked in a very different taste.

At this time, in Holland, throughout the seventeenth century and later, flourished a whole host of *genre painters*; in fact, *genre* and *Dutch style* are almost synonymous. The principal of these were: the Brueghels, Jan and Pieter, known respectively as Velvet and Hell Brueghel; Adrian Brouwer, Karel du Jardin, Pieter Laer (called Bamboccio), Jan van Hugtenburg, Philip Wouverman (1620–68); Pieter de Hooghe, Nicolas Maas (1632–93), Gabriel Metsu, Frans van Mieris (1635–81), Gaspar Netscher, Adrian van Ostade (1610–85), Paul Potter, Jan Steen, who seems to have taken a particular delight in ugliness, David Teniers the younger (1610–94), a great master, and Gerhard Terburg (1608–81). Of landscape and marine painters of this school should be mentioned: Ludolph Bakhuizen, William Vandevelde (1633–1707); Nicolas Berchem, Jan Both, Albert Cuyp, Aart Vander Neer, Jan Vander Meer, Jacob Ruysdael and his great pupil Meindert Hobbema (1638–1709). Of architectural painters the most distinguished were: G. Hoekgeest, Jan Vander Heyden, Pieter Neefs, Hendrik van Vliet, and Hendrik van Steenwyck. Of so-called fruit and still-life painters may be mentioned: Jan Davidsz de Heem, Melchior de Hondekoeter, Jan van Huysum, Rachel Ruisch, Jan Weenix, Jan Wynants, Adrian van Utrecht, Jan Fyt, and Willem Kalf.

The school of the Carracci seems to have taken its deepest root in France, which, with few exceptions, until modern times has not produced artists greatly above mediocrity. The exceptions, however, which may be named are, besides Nicolas Poussin, who has already been mentioned: Eustache le Sueur, Charles le Brun, Sebastien Bourdon, and Pierre Mignard, the great masters of the Louis XIV. period. 'The *Seven Works of Charity*, by Bourdon,' says Fuseli, 'teem with surprisingly pathetic and always novel images; and in the Plague of David, by Pierre Mignard, our sympathy is roused by energies of terror and combinations of woe which escaped Poussin and Raphael himself.'

Claude of Lorraine, though a Frenchman by birth, must, like Nicolas Poussin, be classed among the painters of Rome. Apprenticed at home to a pastrycook, it was at Rome, as the domestic servant of Agostino Tassi, that he learnt the art of painting landscapes which not only immortalised his own name, but are the boast of his countrymen to this day. He died at Rome in 1682, in his eighty-second year; the two Poussins, Gaspar and Nicolas, and Salvator Rosa, the Neapolitan, all remarkable landscape painters, were the contemporaries of Claude at Rome. A more original school of art was established in France in the period of Napoleon. Jacques Louis David (1748–1825) founded a taste, formed from antique sculpture, which superseded all others during the first empire; but the affectation of the antique went so far as to dress men of the nineteenth century in the costume of ancient Rome. Pierre Narcisse Guérin, Jean Germain Drouis, and François Gérard, were the principal masters of this school. A reaction, however, soon supervened, and we have a pure naturalist tendency in the pathetic works of Jean Louis Géricault (1790–1824), and Louis Leopold Robert (1794–1835), a Swiss. Upon this followed the highly refined and sentimental art of Paul Delaroche (1797–1856) and Ary Scheffer (1795–1858). The French school is generally distinguished for the high technical skill of its painters.

From what cause may be difficult to say, but the labours of the Spanish school were confined almost within the limits of individual imitation. The degree of perfection in this respect was indeed great, though the means pursued were very different; and the works of Giuseppe Ribera, Diego Velazquez (1599–1660), at first an imitator of Ribera, and Bartholomé Estében Murillo (1618–82), though never approaching the highest style of art, impress us with respect for their great powers of execution, and deservedly receive the homage of the Spanish nation.

In this country, Henry VIII. was the first monarch who seems to have taken any interest in the art. He invited Titian to England, and by his patronage induced Hans Holbein the younger to settle in this country. Holbein, one of the ablest of portrait painters, and in all styles a great artist, is especially distinguished for the truth and force of his crayon heads, which are unrivalled: he was born at Augsburg in 1495, removed with his father to Basel about 1516, came to England in 1526, and died here of the plague in 1543. Holbein was succeeded by Antonij Moro, the principal painter of Queen Mary; by Lucas de Heere, and Federigo Zucchero, artists employed by Elizabeth.

If painting was at this period likely to have taken root and flourished here, the Reformation, and the worse than absurd edicts passed by Edward VI. and Elizabeth, forbidding statues and pictures in churches, were nipping frosts that destroyed its growth. Charles I. was the first real patron of the arts that governed this country: he formed great collections. By him Rubens and Vandyck were invited to England; but the unfortunate fate of the monarch interrupted the progress that art then seemed likely to make. 'His son,' says Fuseli, 'in possession of the cartoons of Raphael, and with the magnificence of Whitehall before his eyes, suffered Verrio to contaminate the walls of his palaces, or degraded Lely to paint the Cimons and Iphigenias of his court; whilst the manner of Kneller swept away completely what yet might be left of taste under his successors.' We have had some good painters of heads: as Nicholas Hilliard, Isaac Oliver, and Samuel Cooper, in miniature: and William Dobson, Robert Walker, John Riley, and Jonathan Richardson in the natural size. The state of art continued extremely low in this country till the appearance of Sir Joshua Reynolds (1723–92). Walpole says that in the commencement of the

reign of George I. the arts of England were sunk almost to the lowest ebb. The names of Hogarth, Reynolds, Romney, West, Gainsborough, and Wilson, in their time, entitled this nation to some rank in the art; though we have as yet had no indication of that great style the history of which has occupied a considerable portion of the preceding pages. The names we have mentioned have been succeeded by others; as Sir Thomas Lawrence, a fine painter of a female head; Sir David Wilkie, a truly great master in the class of *genre*, as were also William Mulready and Charles Robert Leslie; William Etty, an admirable colourist, equal to the most renowned of any age; and Joseph Mallord William Turner, the prince of landscape painters. There are also some now living, who have not only prevented the accusation of a retrograde movement, but have raised the art generally in the country higher than it was ever known in a preceding period. Yet much remains to be done. The genius of the nation seems bound up in commerce and politics: indifference to the first principles of art seems still to pervade those who only are capable of affording patronage; and many a collector, on whose walls hang splendid specimens of the Roman and Florentine schools, must, if he will speak the truth, admit that his admiration of the well-painted tobacco pipes, pewter pots, and vulgar boors of the Dutch school, is more profound than his feeling for the sublime conceptions of Raphael, or Michael Angelo, or any other great master of the more ideal or abstract provinces of art.

The reader may consult the following works for a more special study of the history of painting: Vasari's *Lives &c. Vite dei più Eccellenti Pittori, Scultori e Architetti*, Le Monnier, Florence 1846–57; Kugler's *Handbook to the History of Painting*, the Italian School, edited by Sir Charles Lock Eastlake—the German, Flemish, and Dutch Schools, by Dr. Waagen, 3rd ed. 1860; Eastlake's *Materials for a History of Oil Painting*, 1847; Stirling's *Annals of the Artists of Spain*, 1848; Raczynski's *Arts en Portugal*, Paris 1846; Villot's *Notice des Tableaux du Musée Impérial du Louvre*, École Française; Michels, *Histoire de la Peinture Flamande et Hollandaise*, Brussels 1845–8; Rathgeber's *Annalen der Niederländischen Malerei &c.* folio, Gotha 1839–44; *Catalogue du Musée d'Anvers*, 2nd ed. Antwerp 1857; Bürger, *Musées de la Hollande*, Paris 1858-60; Crowe and Cavalcaselle, *Notices of the Early Flemish Painters*, 1857, and their *New History of Painting in Italy from the Second to the Sixteenth Century*, 1864; Wornum, *Descriptive and Historical Catalogues of the National Gallery &c.* Foreign Schools, 43rd ed. 1866, British School, 15th ed. 1866; Walpole's *Anecdotes of Painting in England &c.* 3 vols. 8vo. 1849; and Wornum's *Epochs of Painting*, 1864.

Pair Off. In Parliamentary language, when two members of the House of Commons, of opposite political opinions, agree to absent themselves from divisions of the house during a stated period, so as to neutralise each other's absence, they are said to *pair off*; and the term is similarly applied to electors, &c., of opposite views, who agree mutually to refrain from voting.

Paisbergite. [RHODONITE.]

Palace (Lat. palatium). In Architecture, a word generally used to denote the residences of kings, princes, and bishops. On the Continent, however, the term is used in a much more extended signification, as the Palais Législatif, the Palais du Quai d'Orsay, the Palais de la Bourse, in Paris.

Palace Court. A court of justice erected by Charles I., and made a court of record, with power to try personal actions between party and party within a liberty extending to the distance of twelve miles round Whitehall: abolished in 1849.

Paladin. In the Romances of the Middle Ages, a term derived from the Roman palatinus (from palatium, *a palace*), having its origin in the customs of the Byzantine court, by which the officers of the palace (palatini, comites palatii) were regarded as the highest dignitaries of the country; hence palasin, or paladin, in the early French romances, for a lord or chieftain; and the name was thence appropriated by the Italian romantic poets to the heroes of their legends, the warriors of Charlemagne.

Palæocyon (Gr. παλαιός, *ancient*; κύων, *a dog*). A genus of carnassial Mammalia, from the eocene of France, with affinities connecting the canine and ursine types of organisation. It was of the size of a wolf.

Palæography (Gr. παλαιός, *ancient*, and γράφω, *I write*). The science or art of deciphering ancient inscriptions, including the knowledge of the various characters used at different periods by the writers and sculptors of different nations and languages, their usual abbreviations, initials, &c. The science termed diplomatics is, in effect, a branch of palæography. [DIPLOMATICS.] Among many other modern authorities on this subject, the reader may be referred to Mr. Ottley's remarkable paper in the *Archæologia*, vol. xxvi., on an ancient MS. of Aratus; Kopp, *Bilder und Schriften der Vorzeit*, 1819; *Palæo-Critica*, 1817. The most valuable compilation of palæographical knowledge is to be found in the *Traité de Diplomatique* of the Benedictines of St. Maur, 6 vols. 4to. 1748. See also the *Palæographie Universelle* of the Messrs. Champollion, 1840.

Palæontology (Gr. παλαιός, *ancient*; ὤν, ὄντος, *being*; and λόγος, *a discourse*). The branch of zoological science which treats of fossil organic remains.

Palæosaurus (Gr. παλαιός, and σαῦρος, *a lizard*). A genus of extinct lizards, characteristic of the magnesian conglomerate.

Palæotherium (Gr. παλαιός, and θηρίον, *beast*). The name of a genus of extinct Pachyderms. It was characterised by having twenty-eight complex molar teeth, four canines, and

twelve incisors, four in each jaw. Cuvier concludes that the palæotheres, like the tapirs, had also a short fleshy proboscis. Their remains characterise the gypsum quarries belonging to the upper eocene formations near Paris. They have also been found in the corresponding strata of the Isle of Wight. About twelve species of this extinct genus are already known.

Palæozoic (Gr. παλαιός, and ζωή, *life*). The name given by the universal consent of modern geologists to the oldest of the three great groups of fossiliferous strata, commencing with the lower deposits of the new red sandstone, and continuing downwards into the rocks that have not yet been found to contain any fossils. The term simply means *old life*, and refers to the significant and unquestioned fact that in these rocks we see the remains of the most ancient known forms of life that were introduced on our globe. Involving thus no theory, it admits of universal application, and is very convenient. It has entirely replaced the term *primary*.

Much difficulty has been felt in drawing the line of demarcation between palæozoic and mesozoic or secondary rocks. The existence, near the border, of large groups of sandstone very poor in fossils, and the absence of any very distinct want of conformability, which by wide extension may mark an important break in the sequence, has rendered it necessary to resort to fossils as the means of deciding. As these have been more carefully studied, it appears clearly that there exist amongst all adjacent rocks overlapping species, and thus some obscurity and doubt may be felt in particular cases. This is both natural and right; but the result is that a somewhat artificial line has been drawn, applying widely but by no means universally. The existence of groups of fishes in which the vertebral column extends into the tail, is thus regarded as characteristic of the older; while fishes whose tail is set on beyond the extremity of the vertebral column, are characteristic of the newer period. This is regarded as a useful practical guide in distinguishing doubtful cases. There are many other peculiarities of structure and groups of organic beings, which characterise the older series; but no one species or genus of animal is a perfectly safe indication.

The principal subdivisions of the palæozoic series are referred to under separate headings in the pages of this work, and the general classification is given in the article on DESCRIPTIVE GEOLOGY.

Palæozoic rocks are very widely distributed, and are generally regarded as more easily identified by their fossils in distant countries than the newer rocks. No doubt there is a great resemblance between many of the older deposits in the northern part of the northern hemisphere.

The palæozoic rocks are rich in valuable minerals. They include the greater proportion of the metalliferous veins and most of the coal and iron found in England. The absence of such mineral wealth in more recent formations is, however, more apparent than real, and is rather connected with metamorphic action than mere geological age. The rule hardly applies out of Northern Europe.

Palæstra (Gr. παλαίστρα). Properly, a wrestling place or school (πάλη, *wrestling*); and hence the place where public games of strength are performed, and, by metaphor, such games themselves (*studium palæstræ*, Horace). In Architecture, the palæstra was a part of the gymnasium (Pausan. vi. 21, 2, and 23, 4), especially appropriated to the athletes. The art of wrestling was termed *palæstrikê* (παλαιστρική).

Palagonite. A hydrous Scapolite found in amorphous grains and fragments, forming the basis of basaltic tufa and conglomerate, in Iceland and elsewhere. It is of an amber-yellow, yellowish-brown, or blackish colour; and is named after one of the localities, Palagonia, in the Val di Noto, Sicily.

Palanquin. A sort of chair or chaise used by the Chinese and in most parts of the East as a vehicle of conveyance from one place to another. They are furnished with cushions and curtains, and are usually borne by eight men, who relieve each other at intervals.

Palatals (Lat. palatum, *the palate*). The letters *d*, *g*, soft and hard, *j*, *k*, *l*, *n*, and *q*, are so called, from the organ chiefly employed in their pronunciation.

Palate (Lat. palatum). In Anatomy, the roof of the mouth. That part which is formed by the lower portions of the superior maxillary and palatine bones is called the *hard palate*; that which is due to the extension of membranous and muscular substance unsupported by bone is termed the *soft palate*. In Zoology, the modifications of the bony palate, and the *palatal ridges*, and other inequalities of the soft parts, are of use in the discrimination of the species of Mammalia.

PALATE. In Botany, the convex base of the lower lip of a personate corolla.

Palatinate. The name formerly given to two states of Germany, which were designated, by way of distinction, the Upper and Lower Palatinate, and though not contiguous, were under the control of the same sovereign till 1620. At that period they underwent great changes. Since the wars of the first French revolution, which contributed more than any event on record to unsettle the ancient landmarks, they have been divided among different German sovereigns, and their very name has disappeared from the maps of Germany. The word *palatinate* is of feudal origin, and signifies in a more restricted sense the province or seigniory of a palatine; i.e. of a high dignitary during the middle ages, who originally held office in the court of the sovereign, and was designated the *comes palatii*, but who afterwards obtained, within his own province or district, the same power, rank, and jurisdiction, which the comes palatii possessed in the palace. Hence the old German title *pfalzgraf*, count palatine; in English *palsgrave*.

Palatine, County. [COUNTY.]

Palato-pharyngeus. A muscle which arises at the root of the uvula and soft palate, and is inserted into the upper and back part of the thyroid cartilage; it draws the uvula and soft palate downwards and backwards, and pulls the thyroid cartilage and pharynx upwards.

Pale (Lat. palus, *a stake*). In Heraldry, the first and simplest kind of ordinary. It is bounded by two vertical lines, at equal distances from the sides of the escutcheon, of which it encloses one third. It seldom contains more than three charges. The *pallet*, when borne by itself, is one half of the pale; but sometimes as many as three pallets are borne together. A coat bisected by a vertical line, with a different field on each side of it, is said to be *party* (or divided) *per pale*. The pale is a very ancient and honourable bearing.

Pale, Within the. An expression well known in Irish history, applied to that portion of Ireland to which for some centuries after its invasion by the English, under Henry II. in 1172, the dominion of the latter was confined. The limits of the *pale* seldom extended beyond the modern province of Leinster, and were frequently much less considerable. (*Statistics of the British Empire*, vol. i. p. 429; Goldwin Smith, *Irish History and Character*.)

Palese (Lat. *chaff*). In Botany, a name given to the bracts stationed upon the receptacle of *Compositæ* between the florets, and having generally a membranous texture and no colour; also the interior bracts of the flowers of grasses.

Pales (Lat.). In Mythology, the Italian goddess presiding over cattle. Her festivals, called *Palilia*, were celebrated on April 21, the day upon which, according to tradition, the foundations of Rome were laid by Romulus—the dies natalis urbis Romæ—as a great rustic holiday. On this day the shepherds purified their flocks by making them pass round a great fire made of laurel, pine, and olive branches, sprinkled with sulphur. An offering of wine, milk, and millet was then placed on the altar of the goddess, who was entreated to bless the earth and the flocks with fecundity, and to avert injury from them both. This festival was sometimes called *parilia*, from *pario*, as being concerned with the fertility of flocks.

Palfrey (Fr. palefroi, Ital. palafreno). A word seldom used except in novels and romances to signify a small or gentle horse, such as is fit for a lady's use. It is also used by the old poetical writers for a horse used by kings or noblemen, or on state occasions.

Palici (Gr. Παλικοί). In Mythology, twin divinities, worshipped in Sicily, and especially in the neighbourhood of Etna; sons, according to some, of Jupiter and Thalia, the daughter of Vulcan; according to others, of Vulcan and Ætna, daughter of Ocean. Their heads appear on coins of Catania. Their name was supposed to be derived from returning (πάλιν ἱκέσθαι) out of the earth, under which their mother had borne them. (Virg. *Æn.* ix. 585.)

Paligorskite. A white asbestiform silicate found in the mining district of Paligoria in the Ural.

Palilia. [PALES.]

Palillogy (Gr. παλιλλογία, from πάλιν, *again*, and λέγω, *I speak*). In Rhetoric, the repetition of a word, or fragment of a sentence, for the sake of greater energy: also, epanalepsis and epizeuxis. Thus, Cicero (*pro Cæc.* ix. 24), 'Ferro, inquit, ferro, te rejeci;' 'The living, the living, shall praise Thee' (Isa. xxxviii. 19). A peculiar species of palillogy, also called *deuterologia*, or *anadiplosis*, is where the last word of a verse, or of a paragraph in prose, is repeated at the beginning of the next:

> ——supervenit Ægle—
> Ægle Naïadum pulcherrima.—Virgil, *Eclog.* vi. 20.

> ——the innocent sleep—
> Sleep that knits up the ravell'd brow of care.—*Macbeth.*

Palimpsest (Gr. παλίμψηστος). The name given to parchment, from which one writing has been erased to make room for another. The term means literally *twice-rubbed* (*membrana iterum abrasa, charta deletilis*), not, merely, as the glossary of Ducange would seem to denote, because the parchment had undergone erasure, or the writing been obliterated, but because it had been twice prepared for writing, which was principally effected by rubbing it with pumice, first in the course of manufacture after the skin had been cured, and again by the same process after the original writing had been taken away by washing or in any other manner. The practice of making palimpsests is mentioned in a letter from Cicero to Trebatius: 'Ut ad epistolas tuas redeam, cætera bella, &c.; nam quod in palimpsesto, laudo equidem parsimoniam; sed miror quid in illa chartula fuerit, quod delere malueris quam hæc non scribere; nisi forte tuas formulas.' (Cic. *ad Fam.* l. vii. c. xviii.) The attention of the learned was first directed to the subject in modern times by Montfaucon, in an essay entitled *Dissertation sur la Plante appelée Papyrus, &c.*, which appeared in the *Mém. de l'Acad. Fran.* vol. vi.; and in which the origin of the Palimpsest MSS. is described in the following words:—

'Cela (le papier bombycin) vint fort à propos dans un temps où il paroît qu'il y avoit grande disette de parchemin; ce qui nous a fait perdre plusieurs anciens auteurs: voicy comment. Depuis le 12e siècle, les Grecs, plongez dans l'ignorance, s'avisèrent de racler les écritures des anciens MSS. en parchemin, et d'en ôter, autant qu'ils pouvoient, toutes les traces, pour y écrire des livres d'Église: ce fut ainsi qu'au grand préjudice de la république des lettres, les Polybes, les Dions, les Diodores de Sicile, et d'autres auteurs que nous n'avons plus, furent métamorphosez en Triodions, en Pentecostaires, en Homélies, et en d'autres livres d'Église. Après une exacte recherche, je puis assurer que des livres écrits sur du parchemin depuis le 12e siècle, j'en ay plus trouvé dont on avoit raclé l'ancienne écriture, que d'autres.

Mais comme tous les copistes n'estoient pas également habiles à effacer ainsi ces premiers auteurs, il s'en trouve quelques-uns où l'on peut lire au moins une partie de ce qu'on avoit voulu raturer'

The practice of which Montfaucon speaks had a much more ancient date than that which he assigned to it; although it was in all probability most frequent during the middle ages, when, in consequence of the scarcity and expense of parchment, the monks were induced to efface the writings of the ancient authors to make room for their own. On the means adopted by the monks for effacing the original writing, and on that still more interesting process by which in recent times the original writing has been again brought to light, the reader is referred to an article in the *Edinburgh Review*, vol. xlviii., in which all that has been done in the restoration of ancient MSS. is set forth with great clearness. Among the most important works so recovered are the treatise of Cicero *De Republica*, which was found in the Vatican library at Rome, in a MS. which had been rewritten with a Commentary of St. Augustine on the Psalms; and the *Institutes of Gaius*, found by Niebuhr at Verona. (Sandars, *Institutes of Justinian*, 19.) For the restitution of the former the learned world is indebted to Angelo Mai, the principal librarian of the Vatican library at Rome, who may indeed be regarded as the hero of palimpsests; and for the latter to the labours of Bekker and Göschen, who were sent to Rome, for the purpose of examining MSS., by the Royal Academy of Sciences at Berlin.

Palindromus (Gr. παλίνδρομος, *running back again*). A verse or line which was the same when read backwards or forwards. The well-known verse which has been put into the mouth of the devil may serve for an example:—

Signa te, signa, temere me tangis et angis.

Palingenesia (Gr. παλιγγενεσία, from πάλιν, and γένεσις, *birth*). In Philosophy, a new or second birth—regeneration. The doctrine of the destruction and reproduction of worlds and living beings is Oriental; but the word in question appears to be of Stoical origin. (Diog. Laert. vii. 72.) The Stoics are said to have held that the demiurgus, or creator, had absorbed all being in himself, and reproduced it out of himself.

Palingenesis. Production of animals, either from a pre-existent living organism, on which they were parasites, or from putrescent animal matter.

Palinode (Gr. παλινῳδία). In Poetry, a recantation: properly, a piece in which the poet retracts the invectives contained in a former satire. (*Mém. de l'Acad. des Inscr.* vol. xii.)

Palinurus (Gr. Παλινοῦρος). The steersman of the vessel of Æneas, drowned, according to Virgil, off the coast of Italy (*Æn.* v.), and afterwards met with by the Trojan hero in the shades. A promontory on the coast received his name.

Palisades (Fr. palissade, from Lat. palus, *a stake or pole*). In Fortification, strong wooden palings. For use in field-works, they are generally placed in the ditch, and are often made of the rough stems of young trees. For permanent works, they are generally made of a triangular shape, square pieces of timber being cut diagonally to support them, and are usually placed on the banquette of the covered way. They are pointed at the upper ends.

Palissander (Fr. palissandre). A name for Rosewood.

Paliurus (Gr. παλίουρος). *P. aculeatus*, a shrubby plant, belonging to this genus of *Rhamnaceæ*, is said to have yielded materials for the 'crown of thorns,' and hence has been called Christ's Thorn. It has long flexible branches, and each leaf has two sharp spines at its base, one straight, the other hooked. The plant, which inhabits the countries bordering on the Mediterranean, is commonly used for making hedges, and the seeds are considered medicinal, and also tinctorial, being used as a dye.

Pall Mall or **Palle Maille.** An old game, in which an iron ball was struck with a mallet through an iron ring. As being formerly practised in St. James's Park, it has given its name to the street called Pall Mall.

Palla or **Pallium** (Lat.). In Roman Antiquities, the outer garment, of a square or rectangular form, appropriated to females of respectable rank. A part of it was thrown over the left shoulder, and hung down from the arm. It is described by Apuleius (*Met.* xi.). The toga was worn by men, instead of the pallium, during the republic and the earlier emperors. There seems to have been a shorter palla. (Martial i. 93.)

Palladium (Gr. Παλλάδιον). A wooden statue of Pallas, which was said to have fallen from the skies, as a sign to Ilus, the founder of Troy, to convince him that he was under the guidance of Zeus. On its preservation depended the safety of Troy; and, accordingly, Odysseus and Diomêdês were commissioned to steal it. According to other accounts, the palladium was conveyed from Troy to Italy by Æneas, and was afterwards preserved in the temple of Vesta at Rome. The word *palladium* passed into European languages, in which it signifies that particular law or privilege which is regarded as the safeguard of the people's liberties. The trial by jury, and the freedom of the press, are each called the *palladium* of the British constitution.

Palladium. A metal discovered in 1803 by Wollaston, associated with the ore of *platinum*. It resembles platinum in colour and lustre, and it is ductile and malleable, but very hard. Its specific gravity is 11·8. Its fusibility is intermediate between gold and platinum: it is oxidised and dissolved by nitric acid: its oxide forms red salts. Its symbol is Pd, its equivalent 54. Medals have been struck of palladium; and it is sometimes used in the delicately graduated scales of astronomical instruments,

being nearly as white as silver, and not liable to tarnish. Combined with silver, it forms an alloy used by dentists.

Pallas (Gr.). In Greek Mythology, a name of Athênê. Plato derived the word from Gr. *πάλλειν*, *to brandish a spear*, but more probably it is the same as *πάλλαξ*, *a maiden*. [MINERVA.]

PALLAS. One of the four small planets which revolve between the orbits of Mars and Jupiter, discovered by Dr. Olbers of Bremen, on March 28th, 1802. Its symbol was formerly a lance ⚴, but is now ②. On account of the minuteness of this planet, and the nebulous appearance by which it is surrounded, it is extremely difficult to arrive at any certain conclusion respecting its real magnitude. Sir W. Herschel estimated its diameter at eighty miles, and Schroeter at 2,099 miles, or nearly the size of Mercury: but astronomers prefer the former measure.

Pallets. In Clock and Watch work, the pieces connected with the pendulum or balance which receive the immediate impulse of the swing-wheel or balance-wheel. They are of various forms and constructions, according to the kind of escapement employed.

Palliobranchiates (Lat. pallium, *a mantle*, and branchia, *gills*). The name of an order of Acephalous Molluscs, including those in which the gills are situated on the internal surface of the lobes of the mantle.

Pallium (Lat. *a cloak*). A vestment which by ancient usage is sent from Rome to all archbishops of the Roman Catholic church, and to the four Latin patriarchs of the East, on their accession. The history of this usage, and the gradual submission of the Western patriarchs to it, thereby acknowledging in the end the complete authority of the see of Rome, is carefully traced by M. Rheinwald, in the *Encyclopædia* of Ersch and Gruber, art. 'Pallium.' It is now a white woollen band, made round and worn over the shoulders, crossed in front, with one end hanging down over the breast; the other, behind it, is ornamented with purple crosses, and fastened by three golden needles or pins. It was the custom, at the period of the greatest power of the Roman see (introduced by Gregory VII. himself), for the archbishops to come to Rome for the purpose of receiving it; it is now delivered as a mandatory, or merely by a delegate from Rome. Some simple bishops receive the pallium as a mark of honour. The cloth of which the pallium is made is woven from the wool of ten white lambs, blessed at Rome on the festival of St. Agnes, and deposited on the tomb of St. Peter during the eve of his festival. (Hook, *Church Dictionary*.)

Palm (Lat. palma, *the hand*). An ancient measure of length taken from the extent of the hand. There were two different palms; one corresponding to the length of the hand, and the other to the breadth. The Roman palm was about eight and a half English inches. The English palm is understood to be three inches.

PALM. In Sea language, a peculiar thimble used in sailmaking. The word also denotes the flattened end of each arm of an anchor, terminating in a point to enter the ground, while the breadth of the palm gives a good hold.

Palm Oil. An article imported from the west coast of Africa. It is solid, and of a reddish-yellow colour, and has a faint odour of violets. It is largely used in the manufacture of soap and candles, and is sometimes burnt in lamps, and made into ointments. Mixed with tallow and a little caustic soda, it forms one of the varieties of railway grease. It is chiefly the produce of the *Elæis guineensis*.

Palm, Order of the Fruitful. A society formed in 1617 in Germany, and connected by a species of chivalrous institution, for the preservation and culture of the German language. Lewis, prince of Anhalt, was the first head of the order. This body is said to have done much for the German language, but to have ended by attempting too much in the way of refinement and innovation. It was dissolved in 1680. (Ersch and Gruber's *Encyclopædia*.)

Palm Sunday (Dominica Palmarum, Pascha Floridum). The Sunday before Easter, or the day of celebration of the triumphal entry of Christ into Jerusalem. The custom of carrying palm branches on particular days of festivity was an older Jewish observance. The feast of Palm Sunday appears to have been observed all along in the Eastern Church, but is said to have been revived in the West by Gregory the Great. The earliest known Latin homily for the day is by the Venerable Bede.

Palms (Lat. palma). These plants, called by Linnæus, from their noble and stately appearance, the princes of the vegetable kingdom, constitute the natural order *Palmaceæ*, or *Palmæ*, a group of arborescent Endogens, chiefly inhabiting the tropics, distinguished by their fleshy, colourless, six-parted flowers, enclosed within spathes; their minute embryo, lying in the midst of albumen, and remote from the hilum; and rigid plaited or pinnated inarticulated leaves, sometimes called fronds. Wine, oil, flax, flour, sugar, and salt, says Humboldt, are the produce of this tribe; to which Von Martius adds thread, utensils, weapons, food, and habitations. The most common species is the Cocoa-nut Palm. Their wounded stems, or spathes, yield in abundance a saccharine fluid, known in India by the name of *toddy*. The succulent rind of the Date is a most nutritious as well as agreeable fruit. Sago is yielded by the interior of the trunks of many species; and the fruit of the *Areca Catechu*, the well-known *Pisang*, or Betel-nut, is remarkable for its narcotic or intoxicating power. The common Canes or Rattans of the shops are the flexible stems of species of the genus *Calamus*.

The Palms form rather an extensive family, and the species are applied to a vast number of economic uses. They are usually simple-stemmed, but in at least one genus this characteristic is departed from, the species *Hyphæne* frequently producing a large head of branches.

Palma Christi (Lat.). One of the names of the Castor-oil plant, *Ricinus communis.*

Palmares (Lat. from palma, *the hand*). Muscles belonging to the hand. The *palmaris brevis* is situated between the wrist and little finger, and assists in contracting the palm of the hand; the *palmaris longus* is on the fore-arm, and bends the hand.

Palmate (Lat. palmatus). In Botany, a term applied to leaves and other bodies with five or seven lobes, meeting in a common point, and resembling a hand when spread out.

Palmer. In Mediæval History, a name popularly given to crusaders returned from the holy war, or pilgrims from Palestine, from the palm-branch which they were wont to carry as a staff in commemoration of their journey.

Palmer Worms. By this name are known the hairy caterpillars of certain nocturnal moths, used as bait in trout-fishing.

Palmic Acid. The acid obtained by the action of hyponitric acid upon castor oil.

Palmipeds (Lat. palmipedes, from palma, *a palm*, and pes, *a foot*). The name given by Cuvier and Temminck to an order of birds corresponding to the *Anseres* of Linnæus, and the *Natatores*, or swimming birds, of Illiger.

Palmistry (Lat. palma, *the hand*). A species of divination, which professed to foretell future events from the inspection of the lines and marks on the hands and fingers. [CHIROMANCY.]

Palmitic Acid, Ethalic, Cetylic, or Olidic Acid. A colourless, crystalline, inodorous body, existing frequently in the free state in palm oil, and in the combined form in spermaceti.

Palmyra Wood. The wood of the *Borassus flabelliformis*, and of *Cocos nucifera.*

Palo de Vaca. The South American name of the COW-TREE, *Brosimum Galactodendron.* [BROSIMUM.]

Palp (Lat. palpare, *to touch softly*). A jointed sensiferous organ, attached in pairs to the *labium* and *maxilla* of insects, and termed respectively *labial* and *maxillary* palpi, or feelers.

Palpators (Lat. palpator, *one who caresses*). The name of a family of Clavicorn beetles, including those which have very long maxillary feelers, or palps.

Palpebræ (Lat.). The eyelids; the upper and under uniting at each end to form the *canthi.*

Palpitation (Lat. palpitatio, *a throbbing*). This term is especially applied to irregularities of the heart's action, which are frequently the result of indigestion, of nervous excitement, or mental agitation.

Palsy. [PARALYSIS.]

Paludamentum. The peculiar military dress of a Roman general (imperator), in the times of the republic, afterwards adopted by the emperors. It was worn only in the campaign, and exchanged for the toga in Rome. Vitellius, according to Tacitus, was advised not to enter the city in it, as it would be making it look like a city taken by storm. (*Hist.* ii. 89; *Mém. de l'Acad. des Inscr.* vol. xxi.)

Paludina (Lat. palus, *a marsh*). A genus of fresh-water or marsh snails; so called from their location in marshes, ditches, and slow streams. Many species are common in Great Britain; a beautiful example, called the agate marsh-shell (*Paludina achatina*, Lam.), may be found in the smaller tributaries of the Thames.

Pampas. Treeless plains extending for 2,000 miles from the tropic of Capricorn to the southern limit of the American continent on the east side of the Andes. The breadth varies from 240 to 500 miles. The total area is estimated at 750,000 square miles.

Within this wide range of country there are necessarily great differences of climate. For the most part the plains form steplike terraces, ranging north and south and rising to the west. Generally sterile, their steps are sometimes richly covered with verdure. They are here and there intersected by streams, but the waters flowing over them do not fertilise the soil. Huge boulders occasionally interrupt the dreary flat, black lava platforms sometimes intervene, and white incrustations of salt are not wanting. Swamps occur in the southern part of the tract, which are occasionally flooded by the rivers and entirely inundated. In other districts these remarkable platforms are exceedingly fertile, and they are estimated to feed at least a million of horned cattle and three millions of horses, all of which are derived from animals introduced by the Spaniards. The higher plains to the west are less fitted for natural pastures, but admit of very successful cultivation. A large salt desert forms the northern termination of the Pampas.

Pampas Grass. The garden name for a fine grass of Buenos Ayres, *Gynerium argenteum*, much cultivated on account of its ornamental character.

Pampean Formation. A vast extent of fossiliferous deposits in South America belonging to the newer Tertiary period. This group of rocks ranges for a distance of 1,400 miles from north to south, with a breadth of nearly 400 miles, and everywhere contains remains of shells of the same species as those found in the adjacent seas. The elevation above the sea varies from 100 to 400 feet The rocks consist for the most part of ca reous mud with many concretions, and abound with the bones of some gigantic extinct quadrupeds. The deposit appears to have been formed gradually on an ascending coast line.

Pampelmouse. The fruit of *Citrus decumana.*

Pamperos. Violent south-west winds which sweep over the Pampas of Brazil.

Pamphlet (from Span. papelete, by the insertion of the nasal: Wedgwood). In Printing, a short treatise or essay, generally speaking on some subject of temporary interest, which excites public attention at the time of its appearance. We commonly understand by the word *pamphlet* a production of the above

character when it comes from the publishers merely stitched together in sheets, and not bound. Books in octavo, of five sheets, or under, are technically termed *pamphlets*. The word is used by Chaucer. Pamphlets became of common use in political and religious controversy about the middle of the sixteenth century; in England under the reign of Elizabeth; in France, during the wars of religion.

Pampre (Fr.; Lat. pampinus, *a tendril or vine leaf*). In Sculpture, ornaments consisting of vine leaves and grapes.

Pan (Gr.). The chief rural divinity of the Greeks, who presided over flocks and herds. He was said by some to be the son of HERMES, born in Arcadia. At Athens his worship, we are told, was not introduced till the time of the battle of Marathon. (Herod. ii. 145.) He was represented with the head and breast of an elderly man, while his lower parts were like the hind quarters of a goat, whose horns he likewise bore on his forehead. His emblems were the shepherd's crook and the pipe of seven reeds.

Panabase. A mineralogical name for Tetrahedrite or Grey Copper-ore.

Panacea (Gr. πανάκεια). Literally, a remedy which professes the power of curing all sorts of diseases. The idea was personified in Panacea, a daughter of Æsculapius, to whom, in conjunction with her better known sister, Hygieia, the power of healing all diseases was ascribed.

Panada (Ital. pane, *bread*). Bread or biscuit steeped or boiled in water so as to acquire a soft consistence. 'Place thin slices of the crumb of bread in a saucepan, and add rather more water than will cover them; then strain off the superfluous water and beat up the bread till of the consistence of gruel; sweeten it, and add, when proper, a little sherry.' (Pereira *On Food and Diet.*)

Panathenæa (Gr. Παναθήναια). The great national festival of the inhabitants of Attica, celebrated in honour of Athena. [MINERVA.] There were two solemnities of this name, the great and the little. The former were celebrated once in every five years; the latter in every third year, or, as some think, every year. The exhibitions at these festivals were torch races, gymnastic, musical, and poetical contests, with sacrifices and feasts; and, at the great Panathenæa, the sacred stole (πέπλος), decorated by the hands of chosen virgins with embroidery representing the deeds of heroes and patriots, was hung like a sail on a machine in the form of a ship, and thus conveyed up to the Acropolis in a procession, and placed on the statue of Athena.

Panax (Gr.; another form of πανακής, *all-healing*). A name applied to some plants of the Araliaceous order, which are held in high estimation in consequence of their real or supposed virtues. The root of *P. Schinseng*, called Ginseng, is highly valued by the Chinese physicians, from its reputed power of warding off fatigue and invigorating the feeble frame; in China it has sometimes been sold for its weight in gold, but in Europe it has failed to produce any remarkable effects. The roots of the North American *P. quinquefolium* are also highly valued.

Pancartes or **Panchartæ.** In Diplomatics, royal charters in which the enjoyment of all possessions enumerated in the instrument is confirmed to a subject. The word, however, is used in other and looser significations.

Pancratium (Gr. παγκράτιον, literally *a complete contest*). A kind of athletic contest practised by the Greeks, which combined wrestling and boxing together.

PANCRATIUM. In Botany a genus of *Amaryllidaceæ*, of which the European *P. maritimum*, though not now regarded as officinal, has properties resembling those of the squill. There are many tropical species which are extremely ornamental. They characterise a section of the order distinguished by the presence of a cup or coronet within the perianth, the stamens being borne on the cup.

Pancreas (Gr. πάγκρεας). A glandular viscus of the abdomen, situated under and behind the stomach; its duct enters the duodenum, into which it conveys the pancreatic fluid. It is commonly called the *sweetbread* in animals.

Pancreatic Fluid. This is a colourless viscid liquid, secreted by the pancreas. It is alkaline, and rendered frothy by agitation. It yields from 8 to 9 per cent. of a solid residue, of an albuminoid nature, and when heated sets into a solid like ovalbumen. It is precipitated from its aqueous solution by alcohol; but an excess of water redissolves the precipitate. When the solid residue is incinerated, the ash yields chloride of sodium, with phosphate and carbonate of soda. The nature of the organic principle is not well understood. It appears in some respects to resemble ptyalin; but its characteristic property is to assimilate oily matters. It forms an emulsion with oils and fats, when the mixture is heated to about 100°; this appears to be a process of saponification, glycerine is produced, and the fatty acids are set free. The pancreatic juice is the only animal secretion which resolves fatty matters into glycerine and fat-acids, and it does this independent of its alkalinity. [NUTRITION.]

Pandæmonium (Gr. πᾶν, and δαίμων, *a demon*). The general appellation bestowed by Milton on

> —— the high capital
> Of Satan and his peers.—*Par. Lost*, i. 81.

Pandanaceæ (Pandanus, one of the genera). A natural order of arborescent Endogens inhabiting the Indian Archipelago, and most of the tropical islands of the Old World. They have the aspect of gigantic pine-apples, bearing the flowers of a *Sparganium*, and are remarkable among arborescent Monocotyledons for their constant tendency to branch, which is always effected in a dichotomous manner; and also for their leaves being arranged so distinctly in a spiral manner that they have acquired the common name of *Screw Pines*. The principal genus is *Pandanus*, of which

many species are known. *P. Candelabrum* is the Chandelier-tree of Guiana. *P. utilis*, the Vacona of the Mauritius, is extensively grown for the sake of its leaves, which are made into bags or sacks for sugar. *P. odoratissimus* has very fragrant flowers. The seeds of some of the species of this genus are edible.

Pandects (Gr. πανδέκται, lit. *all-receiving*). The great compilation of the Roman law published by the emperor Justinian. [DIGEST.]

Pandiculation (Lat. pandiculor, *I gape*). The gaping, yawning, and stretching that characterises some diseases. It sometimes occurs in the cold fit of an ague.

Pandit. The title of learned Brahmins in Hindustan. The term is used ironically in England to designate anyone who makes a vast show of learning without possessing it in reality.

Pandora (Gr. from πᾶν, and δῶρον, *a gift*). In Grecian Mythology, the name given to the first woman, according to Hesiod. She was formed of clay by Hephæstus, at the request of Zeus, and was created for the purpose of punishing PROMETHEUS. All the gods vied in making her presents; and thus arrayed, she was brought to Epimetheus, who had been warned by his brother Prometheus to receive no gifts from the gods; but charmed by her beauty, he received Pandora, who on his threshold lifted the cover of the cask in which all evil things were shut up. In her terror, she replaced the covering, and Hope alone remained a prisoner beneath it.

Pandore (Gr. πανδοῦρα, Fr. mandore). A musical instrument of three strings.

Pandours. A kind of light infantry, formerly organised as separate corps in the Austrian service: raised from the Servian and Rascian inhabitants of the Turkish frontier, and originally under leaders of their own, styled *harumbachas*. Since 1756, they have been included in the regular army.

Panduriform. Literally, *fiddle-shaped*; a term applied by botanists to the leaves of some plants which in outline somewhat resemble the form of a PANDORE or violin.

Panegyric (Gr. λόγος πανηγυρικός, *a speech addressed to a general assembly*, πανήγυρις). In Oratory, a eulogy or harangue, written or spoken, in praise of an individual or body of men. Among the ancients, orations were recited in praise of the departed on various occasions, before solemn assemblies; hence the name. Among the later Romans, the baser practice prevailed of reciting panegyrical orations on distinguished living persons in their presence. Among the moderns, panegyrical oratory has been chiefly confined to funeral discourses from the pulpit. In France, however, the éloges or orations, pronounced in some literary and scientific societies on the decease of a member, bear something of the character of classical panegyrics.

Panel (said by Sir H. Spelman to mean or *schedula*, as a *panel* of parchment, In Law, a roll containing the names of jurors whom the sheriff returns to pass on a trial. In Scottish Law, the accused person in a criminal action from the time of his appearance is styled the *pannel*. For various opinions on the origin of the word see Wedgwood, *Dictionary of English Etymology*, s.v. 'pane' and 'pannel.'

Pangiaceæ (Pangium, one of the genera). A small order of Dicotyledonous plants belonging to the Papayal alliance, in which they are distinguished by their polypetalous flowers, with a scale at the base of each petal. *Pangium edule* is a Javanese tree with hard solid wood. The bark and leaves contain a poisonous principle; but the kernels of the seeds, macerated in cold water to remove the noxious narcotic qualities, are occasionally used as a condiment.

Panic. A word usually applied to a sudden and groundless alarm, the myth being that Pan, during the Indian expedition of Bacchus, was surrounded by enemies, and that the shouting of his men, favoured by the echoes of a rocky valley, so frightened them that they instantly took to flight.

Panic, Commercial. In the ordinary course of trade, the amount of money and the discount accommodation afforded by the several banks are proportioned to the amount of assistance generally required by traders. A rate of profit due to the skill, labour, and risk of the borrower, can be effected in commercial transactions in addition to the rate of profit procurable from the ordinary employment of capital at interest. Hence, as long as there exists a difference between the profit derived in trade and the interest paid for capital, borrowers will always draw upon the funds of lenders, and the two will share the proceeds of the investment. Nothing, however, but caution on the part of lenders will prevent borrowers from occasionally interpreting a future profit as greater and surer than events prove it to be, and from incurring a loss which may not only sacrifice whatever capital they possess themselves, but also that which they have borrowed; and there are events occurring from time to time in the course of trade, which no prudence could foresee and no caution avoid. If with these we take into account the occasions on which fraudulent or injudicious speculation is rife and a temper of risking capital in what appear to be promising ventures becomes contagious, we see at once the elements out of which a commercial panic can be developed.

It is not possible to draw a sharp line of distinction between overtrading or speculation, and legitimate commercial risk. In all trade some elements of peril are always present. The most prudent person may find that he has produced overmuch, that he was deceived in the market for which he has supplied shipments, that the demand he anticipated has failed to exist either in part or wholly, that a glut has occurred by simultaneous shipments, or that he has unconsciously over-traded by some other obvious and natural error. But, on the other hand, traders may be reckless and unscrupulous, or be filled with hopes that a monopoly of some

article may be secured out of which large profits are to be derived.

All purchases, whether real or speculative, act on prices. A buyer, whether he pays ultimately or not, enhances the market value of a commodity by the fact of his demand. In the ordinary course of things, the mutual competition of buyers and sellers is beneficial to the public, because it steadies price and equalises supply. Speculation, however, is always relative to a scanty supply, or to a supply the quantity of which is not likely to be or cannot be increased at pleasure. Suppose the article to be one of high necessity or great convenience, and the competition of buyers forces the price up to a very great increase above its ordinary rate. A reaction then upon the market, due to an unexpected supply from another quarter, or to a disinclination on the part of the public to endure the enhanced cost, may occur, and the price will drop, and with a falling price very frequently involve the bankruptcy of the speculator. If the transactions on which the speculation is based are large, and the competition active, the indebtedness of one or more houses may induce the ruin of others, and a collapse is inevitable, and with it a large destruction of that form of capital which is founded on credit.

It has been already stated [CURRENCY], that bankers are the agents by whom borrowers and lenders are brought together. The banker discounts the bill of his customer, partly out of his own capital, partly out of the deposits of other customers. If he gives no interest on deposits, as is the practice of the Bank of England and most private banks, the banker appropriates all the profit which is procured by advances on discount; if he gives interest, as is the case with most joint-stock banks, the profit derived is contained in the difference between the rate of interest on deposits and the market rate of discount, a sum which, though representing a small percentage, is in effect a large actual profit on numerous and extensive transactions. The depositors in banks, if commercial men, are also its customers for discount; a sum varying in extent with the funds and credit of the customer being ordinarily allowed on commercial bills. When, however, applications for discount are very pressing, as when large purchases are made, or trade is excessively active, or a large amount of deposits are withdrawn for investment, either in home or foreign undertakings, or when the state of the exchanges indicates a drain of bullion, or similar causes arise, the banker contracts his accommodation, and the discounter, either mediately by means of bill brokers, or immediately by personal application, draws on the resources of the Bank of England. In order to meet this increased demand on the funds available for trading purposes and at the disposal of the Bank, the Bank raises its rate of discount, and thus attempts to check the applications. If, however, their necessities are urgent, or the anticipated rate of profit is still tempting, this enhanced rate (followed, of course, by the other banks, who take the initiative of the Bank of England as their rule), is endured by the commercial world, and the applications remain as large, and are met again by a rise in the rate, these alternate demands and checks continuing till the demand is greatly diminished, and the resources of the Bank are restored. But the rate may be raised to such a height, and the demand may be so urgent, that a collapse of credit takes place, and large bankruptcies ensue; in other words, a commercial panic occurs. And as, of course, not only the speculators, but persons engaged in legitimate and prudent trade, must pay equally the advanced rate of discount, it often happens that traders of undoubted solvency, and whose capital is more than fully equal to the complete liquidation of all claims upon them, are forced to suspend payment, and suffer all the inconveniences of a failure.

The difficult question, whether the effects of a commercial panic are not exaggerated by the restrictions of the Bank Act of 1844, is one which is still debated with great warmth. The object of the Bank Act was, unquestionably, to diminish the risk of a crisis by checking the power of advance in limine. It was supposed that the tendency to speculation was increased by the power which a bank possessed, before the Act, of issuing its notes according to its own discretion, a discretion unlimited by any consideration beyond that of due regard to its own solvency, i. e. to the convertibility of its paper. The object may have been in part fulfilled; that is to say, the circumstances tending towards a commercial crisis may have been, before the Act, protracted, and the recoil from an undue inflation may have been more severe. But panics have not been prevented, nor have enormous commercial losses, due to the certain destruction of credit, been obviated by the operation of the Act, while the means for meeting the temporary difficulties incurred by houses of undoubted solvency have been largely curtailed, if not entirely taken away. Mr. Mill thinks that the disadvantages of the Act greatly preponderate over its advantages, though he makes the statement with caution, and with the reserve due to the magnitude, intricacy, and importance of the subject.

In the modern history of banking, four noteworthy cases of commercial panic or crisis have occurred. In 1825, the panic is ascribed to enormous mining speculations and the negotiation of loans to the nascent trans-Atlantic republics. In 1839, American speculations of large amount were, it is said, the cause. The cotton failure in America and the generally deficient harvests of 1846 and 1847, are cited as the causes of the panic of these years; while the extensive failures of Scotch and American houses are supposed to account for the crisis of 1857. On the last two occasions the provisions of the Bank Act were suspended, and the restoration of commercial confidence was the immediate result.

All experience has confirmed the alarm felt

at the commercial consequences of undertakings whose magnitude is such as to require for their completion either a supply of capital in excess of that which is annually accumulated out of savings, or a diversion of existing capital from ordinary to novel occupations. Such was the case in the railway mania, when parliament sanctioned, with singular inconsiderateness, such a number of operations as would have exhausted ten times the amount of annual savings, and in the year 1864, when similar, though not equal speculation, took the direction of limited joint-stock companies. Mr. Mill has enumerated four causes as tending to a commercial crisis: 1. Extraordinary war expenditure. 2. Large exportations of capital for foreign investment. 3. Failure in the crop of some country which supplies a necessary raw material. 4. Failure on a large scale of a harvest at home, and therefore the necessity of importation. To these may be added, 5, The extraordinary developement of commercial undertakings at home, tending to make a drain on capital, or to divert it from its customary employment.

Panicle. In Botany, a form of inflorescence in which the primary axis developes secondary axes, which themselves produce tertiary. In other words, a raceme bearing branches of flowers in place of simple ones.

Panicum (Lat.). A very extensive genus of Grasses, some of which, as *P. miliaceum*, *pilosum*, and *frumentaceum*, are extensively grown in warm countries for their grain, which constitutes some of the varieties of Millet. In tropical and sub-tropical regions they form the chief of the fodder grasses.

Pannel (Fr. panneau). In Architecture, an area sunk from the general surface of the surrounding work. In Joinery, it is a tympanum, or thin piece of wood, framed, or received into a groove by two upright pieces, and two transverse rails or cross pieces, at the top or the bottom. [PANEL.]

Panoply (Gr. πανοπλία). Literally, all the armour that can be worn for defence; complete armour.

Panopticon (Gr. πᾶν, and ὄπτομαι, *I see*). A term coined by Jeremy Bentham to denote the plan of the prison which he designed and recommended for adoption in his *Theory of Punishments*. This building was distinguished by three leading properties, for an account of which the reader is referred to vol. xxii. of the *Edinburgh Review*, pp. 19, 20; but its greatest peculiarity consisted in its form, and in the disposition of its cells, which were so constructed that the inspector could see each prisoner at all times without himself being seen; and hence the origin of the term.

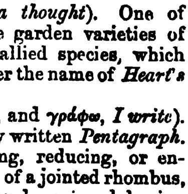
Panorama (Gr. πᾶν, *all*, and ὅραμα, *a view*). A picture in which all the objects of nature that are visible from a single point are represented on the interior surface of a round or cylindrical wall, the point of view being in the axis of the cylinder. The rules according to which the different objects are represented in perspective are easily deduced from the consideration that the lines on the panorama are the intersections of the cylindrical surface of the picture with one or more conical surfaces having their summits at the point of view, and of which the bases are the lines of nature which the artist proposes to represent. In executing this kind of perspective the artist divides the horizon into a considerable number of parts, twenty, for example, and draws, in the ordinary way, on a plane surface, a perspective view of all the objects comprised in each of these portions of the horizon. He then paints on a canvas representing the developement of the cylindrical surface, the twenty drawings, in as many vertical and parallel stripes; and the picture is completed by stretching the canvas on the cylindrical wall of the rotunda which is to contain the panorama. When a painting of this kind is well executed, its truth is such as to produce a complete illusion. No other method of representing objects is so well calculated to give an exact idea of the general aspect and appearance of a country as seen all round from a given point.

The first panorama exhibited in London was painted by Robert Barker in 1789; it represented a view of Edinburgh. A panorama of London was the first that was introduced into Germany, in 1800. Since that time they have become common in all the principal cities of Europe. Barker was the inventor of panoramas. He built and opened the circular exhibition rooms in Leicester Square in 1793. After his death in 1806 the exhibition was carried on by his son, Henry Aston Barker, and Robert Burford. The latter produced a grand series of panoramas, and died, in his seventieth year, on January 30, 1861.

Panstereorama (Gr. πᾶν; στερεός, *solid*). A model of a town or country, in relief, executed in cork, wood, pasteboard, or other substances.

Pansy (Fr. pensée, *a thought*). One of the names applied to the garden varieties of *Viola tricolor* and some allied species, which are usually cultivated under the name of *Heart's ease*. [VIOLA.]

Pantagraph (Gr. πᾶν, and γράφω, *I write*). Frequently but improperly written *Pentagraph*. An instrument for copying, reducing, or enlarging plans. It consists of a jointed rhombus, A B C D, made of wood or brass, and having the two sides B A and B C extended to double their length. The side A D and branch A E are graduated from A, in such a manner that if O and T be corresponding divisions, A O is to B O in the same ratio as A T to B E or B F. Small sliding boxes for holding



a pencil or tracing point are brought to the corresponding graduations, and fixed in their positions by screws, and a third is fixed at the point F. Now, since in every position of the in-

strument the two sides A D and B F are parallel, and the points O and T are so taken that O A : A T :: O B : B F, the three points O, T, and F must necessarily range in a straight line; consequently, if any one of these three points be taken as the centre of motion, and another of them be carried along the boundaries of any figure, the third will trace out a similar figure, reduced or enlarged according as it is nearer to or farther from the centre of motion than the point which is carried along the figure to be copied. The pantagraph was invented by the Jesuit Christopher Scheiner, in 1603, and is described by him in a tract entitled *Pantographice sive Ars Delineandi, &c.*, published at Rome in 1623. A more perfect instrument for accomplishing the same objects has been invented by Professor Wallace of Edinburgh. [EIDOGRAPH.] Both instruments may be so modified as to produce a reversed representation of the figure to be copied; an application which is extremely useful for the purposes of copperplate engraving and lithography.

Pantaloon (Ital. pantaleone). One of the chief characters in all pantomimic representations. The pantaloon of the original Italian pantomime was a Venetian burgher, said to have been so called from the words 'pianta leone,' *the planter of the lion*, the banner of Venice.

Pantechnicon (Gr. πᾶν, and τέχνη, *art*). A place in which every species of workmanship is collected and exposed for sale.

Pantheism (Gr. Πᾶν, and Θέος, *God*). In Metaphysical Theology, the theory which identifies nature, or the τὸ πᾶν, the universe in its totality, with God. This doctrine differs from atheism in the greater distinctness with which it asserts the unity and essential vitality of nature; parts of which all animated beings are. The most ancient Greek philosophers were pantheists in this sense; Anaxagoras being the first who distinctly stated the coexistence with nature of a reasonable creator—'a mind, the principle of all things.' In this sense, too, Spinoza may be called a pantheist. The pantheism of Schelling and many modern German philosophers is of a different stamp. According to these thinkers, God is conceived as the absolute and original Being, revealing Himself variously in outward nature, and in human intelligence and freedom. It is not easy to see how pantheism in this sense differs from the Christian view of God, as expressed in the language of St. Paul, 'in Whom we live, and move, and have our being.' The world is, indeed, conceived to be animated by the presence and agency of the Deity; but His distinctness and independent subsistence are definitely laid down as the condition and ground of all phenomenal existence, and of reason itself.

Pantheistic. In Sculpture, a term applied to statues and figures which bear the symbols of several deities together, the meaning of which has been a subject of dispute among antiquaries.

Pantheon (Gr. πάνθεον). Literally, a temple dedicated to all the gods. There were two magnificent structures so named, one at Athens, the other at Rome. The latter still exists, though comparatively in ruins. The foundation of this building is generally ascribed to Agrippa, the son-in-law of Augustus. It now forms a Christian church, dedicated to the Virgin Mary and All Saints, and generally called the Rotunda. The form is circular, and its roof a hemispherical dome 144 feet in diameter, its height being the same from the pavement to the top of the dome. It has a Corinthian portico, consisting of sixteen granite columns, of which eight stand in front. Pliny ranked this edifice as one of the wonders of the world. Since its erection, it has been grievously spoiled of its ornaments. The term *pantheon* has been absurdly applied to places of public exhibition in which every variety of amusement is found.

Panther (Gr. πάνθηρ). A name given by the earlier French zoologists to an Indian variety of the Leopard (*Felis leopardus*), which was supposed to differ from the more typical individuals found in Senegal. The panther and leopard are now classified by zoologists as one single species, which Dr. Gray has termed *Leopardus varius*.

Pantile. A tile cast in a curvilinear form, favourable to the flow of water. *Pan* tiles differ from *plain* tiles in this respect, that the latter are made as plane as possible; the former are cast with a channel in the centre.

Pantisocracy (Gr. πᾶς, *all*; ἴσος, *equal*; κρατέω, *I govern*). A fanciful name, invented by some enthusiastic politicians in this country in the latter period of the French revolution, for a scheme of equal government and socialism. Southey, Coleridge, and some of their friends, joined in it, and were at one time engaged in a project of emigration to America in order to carry it out. Byron calls it 'a scheme less moral than 'twas clever.'

Pantochronometer (Gr. πᾶν; χρόνος, *time*; and μέτρον, *a measure*). A term recently invented and applied to an instrument which is a combination of the compass, the sun-dial, and the universal time-dial, and performs the offices of all three.

Pantologia (Gr. πᾶν, and λόγος). A work of universal instruction or science; equivalent to DICTIONARY or ENCYCLOPÆDIA.

Pantomime (Gr. παντόμιμος, *all-imitating*). A species of theatrical entertainment, in which, according to the derivation of the word, the whole action of the piece should be represented by gesticulation, without the use of words. The English pantomime is an amusement peculiar to our theatre. A class of actors in vogue at Rome, who performed pieces in dumb show, expressing everything by their dancing and gestures, were called pantomimes, and from them the name of this species of amusement among ourselves has probably been taken. [MIMES.]

Papacy. The office of pope, or, historically, the succession of popes in the see of Rome.

The origin of the term is Oriental. The word papas was used in lower Greek with the signification of father, and is still applied by the Greek church to the priests of that communion. In the Western church, the title was not uncommonly given to bishops in general, and was not confined to the Roman pontiff for several centuries.

1. The Roman church, from its situation, could not fail to exercise a sensible influence over other nations. Before the transference of the empire to the shores of the Bosporus, Rome was still the centre of the civil and commercial world. Thither came those who had fallen under suspicion of departing from the faith, and those also who had accused them of heresy. The decisions of the bishop of Rome, as arbitrating between such persons, were sometimes admitted by more than those in whose favour they were given. Yet the importance thus acquired was not sufficient to establish an inherent supremacy, nor does the idea of such supremacy appear at that time to have entered the minds of the bishops of Rome; and we find Irenæus of Lyons interfering to check the dogmatism of Victor of Rome, and Cyprian maintaining the validity of heretical baptism, in concert with the Asiatic church, and in opposition to the Roman.

2. It is in the fourth century that the first dawn of substantial power appears in the Roman see. Upon the recognition of Christianity by the civil government, the bishop of Rome is found in the enjoyment of precedence among the prelates of the empire. The patriarch of Constantinople is expressly exalted by Theodosius (A.D. 381) to the *second* rank. The canons of the council of Sardica, 347 (the genuineness, however, of which is suspected), allow bishops in certain cases an *appeal* to the Roman pontiff. Even the removal of the seat of government to Constantinople, although the very fact of its residence at Rome had undoubtedly contributed to the pre-eminence of its bishop in earlier times, seems to have favoured the pretensions which the popes began now openly to maintain. Rome was no longer under the immediate eye of the emperor. The patriarch of Constantinople, although he enjoyed the imperial favour up to a certain point, was not allowed to outstep it, and was subject to be deposed if he forgot for a moment the relative position in which he stood. The emperors of the West, on the other hand, took up their abode at Milan, or Ravenna; and when they had been overturned, and the barbarians began to found new dynasties upon the ruins of the Italian provinces, the popes were among their most useful instruments in civilising and consolidating the fragments of their power.

Again, the nearer contact which thus took place between the Italian clergy and the pagans of the north, afforded the popes an opportunity of diffusing the idea of their own supremacy, while at the same time they extended the limits of Latin Christianity; and while Antioch and Alexandria were trembling before the birth of Mohammedanism, and Constantinople was losing one by one its fairest provinces, the dominion of the Western primacy was acquiring daily a wider basis and a more devoted people.

3. With Gregory I., at the end of the sixth century, commenced one of the most important epochs in the papal history. The system of aggrandisement, of which he laid the foundations, consisted in the conversion of the heathen, upon the principle above mentioned, and the connection of the monastic orders with the Roman see, by releasing them from the immediate jurisdiction of their own diocesans.

4. The next important step in the history of the papacy is the famous donation of Pepin, by which the Italian provinces which the French king had conquered from the Lombards were transferred by him, not to his own dominions, nor to the Greek emperor, who had the ancient hereditary claim, but in temporal sovereignty to the pope. But even this political power, thus acquired, was not in itself pregnant with such important consequences as the principle which was sanctioned by the immediate occasion of the donation; for Pepin had taken counsel with Pope Zachary whether he should be justified in overturning the throne of the imbecile prince whose servant he was, and had been formally authorised so to do. The possessions which thus came into the hands of the Roman bishops were confirmed and enlarged by the addition of the territory of Rome itself by Charlemagne, at the close of the eighth century; and the dominion thus acquired, though the sovereignty over them was partially interrupted by various revolutions of the middle ages, continued, until the recent establishment of the kingdom of Italy, to form the temporal patrimony of St. Peter. It is to be observed, that the nature and extent of the power accorded to the popes by Charlemagne has given rise to much dispute; and the partisans of the Roman see have been charged with giving to it a false and exaggerated colouring. 'The original record,' Dr. Milman remarks, 'has long perished; its terms are but vaguely known. . . The nature of the papal tenure and authority is still more difficult to define. Was it the absolute alienation of the whole temporal power to the pope? In what consisted the sovereignty still claimed and exercised by Charlemagne over the whole of Italy, even over Rome itself?'. (*History of Latin Christianity*, book iv. chap. xii.)

5. The dissensions which took place among the successors of Charlemagne in the ninth century afforded a tempting opportunity for political encroachment on the part of the Roman bishops. In 879, Charles the Bald was proclaimed emperor by Pope John VIII., and his immediate successors received their nomination also from the same source. It was in the same century that the forgery of the decretal epistles gave a colour and authority to many temporal claims of the Roman see.

6. It was not, however, till the pontificate of Gregory VII. (1073–1086), that the principle

of temporal aggrandisement received a systematic developement. The grand project which that prelate entertained was to reduce the whole territory of Christendom to a feudal subjection to the holy see. He assumed the right of appointment to all the crowns of Europe; and with such success, that when his principal opponent, Henry IV. of Germany, had succeeded in dispossessing him of his pontifical chair, and placing therein the antipope, Clement III., the victorious monarch continued to recognise, in the creature whom he had thus installed in the papal prerogatives, the very same authority which Gregory had claimed over him, and received from his hands his own imperial crown. A main feature in this political scheme was the reduction of the whole body of the clergy into immediate dependants upon the papal throne. In order to effect this, the law of celibacy was strictly enforced; the elections of bishops by their diocesan clergy discouraged and almost abolished; and their investiture by their national sovereigns, in itself a monarchical usurpation, became the great subject of contention between the pope and the emperor. Although in this struggle the pope was finally unsuccessful, yet principles were advanced during its progress, and claims bequeathed to posterity, which smoothed the way for the more fortunate aggressions of later pontiffs, and exalted the power of the papacy to its greatest height under Innocent III. at the beginning of the thirteenth century.

7. The power of excommunication had been exercised long before the time of Hildebrand; the interdict by which a whole state was laid under a spiritual ban was not adopted till about that period. This weapon was unsparingly wielded by Innocent III.; and the degradation to which John of England was subjected by him through these means is one of the strongest instances of the extent to which the papal power was advanced. But Innocent, although his clergy were better disciplined subjects, and his pretensions invested with the superior efficacy of prescription, had new and greater difficulties to contend with than his famous predecessors. At this time the tide of human opinion was already on the turn. Numerous reforming sects arose and threatened to undermine the fidelity of the lower classes; the princes were more conscious of the yoke which had been imposed upon them, and more anxious to avail themselves of an opportunity to cast it off: the clergy also, the main stay of the papal cause, were beginning to excite general murmurs by their corruption of manners. It is between Gregory and Innocent, therefore, that the period of the substantial greatness of the Roman see must be placed.

Since the Reformation, the adherents of the papacy have been reduced by at least one-third in number, and its pretensions have been practically reduced in more than an equal proportion. At various times it has conceded more or less independence to its clergy, and has tacitly withdrawn its claims to political supremacy. The rights of states and sovereigns have been secured by concordats. The spiritual power which it still retains is a matter of opinion rather than of history; and it is yet to be seen whether the threatened extinction of its temporal sovereignty in the States of the Church will actually weaken or confirm its hold on the consciences of its adherents. [MONACHISM.]

Papaver (Lat.). The principal genus of the order *Papaveraceæ*. It contains some ornamental species, as *P. orientale* and *bracteatum*; some useful kinds, as *P. somniferum*, the Opium Poppy; and some troublesome weeds, as the flaunting Poppy of the cornfields, *P. Rhœas*. *P. somniferum* is very extensively cultivated in India, Persia, &c. for the sake of the opium obtained from its unripe capsules. Its seeds contain a large quantity of pure oil, which is extracted as an article of food. [OPIUM.]

Papaveraceæ (Papaver. one of the genera). A natural order of narcotic plants, belonging to the Polypetalous division and the Ranal alliance of hypogynous Exogens. They are nearly related to *Ranunculaceæ*, with which they correspond in habit and in the structure of the seeds, but differ in having parietal placentæ and a calyx of only two pieces. The Cornfield Poppy, the Horned Poppy, Celandine, *Argemone*, and *Eschscholtzia*, are well-known examples, either cultivated for the sake of their flowers or destroyed as showy but troublesome weeds.

Papaverine (Lat. papaver, *a poppy*). One of the crystallisable basic substances contained in opium, distinguished from the others by giving a deep blue colour with concentrated sulphuric acid.

Papaw (from papaia-marum, its Malabar name). The name of a tropical fruit produced by *Carica Papaya*. [CARICA.]

Papayaceæ (Papaya, a synonym of Carica). A small natural order of the Papayal alliance of diclinous Exogens, distinguished by their monopetalous corollas. The most important plant of the order is the Papaw.

Paper (Fr. papier, Gr. πάπυρος). A thin and flexible substance of various colours, but most commonly white, used for writing and printing, and for other purposes. It is manufactured from vegetable matter, reduced to a pulp by means of water and grinding; and is made up into *sheets*, quires, and reams, each quire consisting of twenty-four sheets, and each ream of twenty quires.

In the early ages of society, various materials were employed for writing purposes; as stones, bricks, tablets of wood, plates of lead, skins, parchment, linen, layers of wax, tablets of ivory, and, above all, the papyrus, all these various materials being resorted to in succession, as the ineligibility of each induced a fresh endeavour to discover some more desirable substitute.

Papyrus Paper.—As our present object is to trace the progress of paper, rather than to enter into a minute account of those materials which were employed antecedent to its manufacture, it will not be necessary to dwell upon

the other substances, which are as diversified as human ingenuity could devise; but pass on to the byblus or papyrus, the immediate precursor of paper, and the article from which it was first manufactured. Egypt has the honour of the invention, and Isidore even fixes the locality at Memphis. Varro, the Roman, ascribes the invention to the time of Alexander the Great, after the founding of Alexandria; but we find in Pliny a passage extracted from the writings of Cassius Hemina (a Roman annalist of the second century B.C.), in which he speaks of some books found in the tomb of Numa when it was opened, 535 years after his decease, and in which he asserts that these books were of *paper*, and had been interred with him. But as Numa belongs rather to mythology than history, the opinion of Hemina as to the genuineness of this tomb is about as valuable as the belief respecting the tombs of Æneas. (Sir G. C. Lewis, *Credibility of Early Roman History*, ch. ix. § 11.) Hence his assertion proves nothing for the antiquity of papyrus paper; but as papyrus seems to have been in high reputation in the time of Alexander the Great, it is probable that improvements were made during his reign which enhanced its value and increased the manufacture.

It is evident, says Sir Gardner Wilkinson (*Ancient Egypt.* vol. iii. p. 61), that the papyrus plant 'from its great value and from its exclusive cultivation in certain districts, where it was a government monopoly, could not have been applied to the many purposes mentioned in ancient authors; we may therefore conclude that several plants of the genus *Cyperus* were comprehended under the head of byblus or papyrus. This is not only in accordance with probability, from their general resemblance, but is expressly stated by Strabo (lib. xvii. p. 550, ed. Cas.), who says that "much grows in the lower part of the Delta, where one kind is of an inferior, and the other of a superior quality, and this last is known by the distinctive appellation of *hieratic byblus*. That the profits arising from its sale may be increased, they have adopted the same plan which was devised in Judæa, regarding the date-tree and balsam, permitting it to grow only in certain places; so that its rarity increasing its value, they benefit themselves at the expense of the community." And that under the name *papyrus* he includes other kinds of *Cyperus*, produced spontaneously in the marshy lands, is evident from his stating that the "papyrus does not grow in great quantity about Alexandria, because it is not *cultivated* there," and Pliny and other writers show that the plant to which they frequently applied this name was wild in many parts of Egypt. There is, therefore, reason to believe that several species were comprehended under the general appellation of byblus or papyrus. The *Cyperus dives*, which grows to the height of five or six feet, is still cultivated in Egypt for many purposes to which the papyrus plant is said to have been applied; and I have no doubt that this was the species commonly employed in former times for making mats, baskets, parts of sandals, papyrus boats, and for other ordinary uses; the *Cyperus papyrus*, or *Papyrus* (*Byblus*) *hieraticus* of Strabo, being confined to the manufacture of

It is true that papyrus continued in use long after the invention of paper; and this is the argument by which it is contended that the manufacture was of more modern date, although the only fair inference seems to be that it was only rare or expensive. It appears, however, that after this time papyrus paper was chiefly manufactured at Alexandria, and continued a source of profit to that city up to the fifth century, to the close of which it remained in general use throughout Europe; Italy retained it to the eleventh, and France even so late as the twelfth century.'

The papers made from papyrus varied much in quality, being dependent on the growth of the plant, and the part of the stalk from which it was taken. The process of the manufacture is minutely described by Pliny, *Hist. Nat.* xiii. 11, 12.

Cotton Paper.—The next improvement in paper was its manufacture from cotton. It is supposed that the Chinese and Persians were acquainted with this material for its production, and that the Arabians learnt it from their conquests in Tartary. The ancient paper bears no marks of the wire through which the water is drained in modern paper-making; and it is therefore inferred that a different process was employed. Paper made from cotton was in use earlier with the Greeks than with the Romans. But the manufacture of paper from cotton cannot be traced farther back than to the tenth century; and the oldest manuscript document written on cotton paper is dated 1050. Eustathius, who wrote towards the end of the twelfth century, states that the Egyptian papyrus had gone into disuse not long before his time. Several letters of the reign of Henry IV., preserved in the Tower of London, are evidently written on cotton paper.

Linen Paper.—When or by whom linen paper was invented, seems uncertain: some give the credit to Germany, some to Italy, some to Greece; but the Chinese appear to have the best pretensions. Dr. Dibdin, in his *Typographical Antiquities*, says that 'the art of paper-making with linen rags is supposed to have been discovered in the eleventh century, though Father Mabillon thinks it was in the twelfth. Montfaucon acknowledges that he has not been able to meet with a single leaf of paper with a date anterior to the death of St. Louis in 1270.' Its introduction into England took place about the year 1342, in the reign of Edward III., although some have placed it as early as 1320. France had it in 1314, and Italy in 1367. The Germans possess a specimen bearing the date of 1308, although it has been surmised that this single instance may have been a mixture of linen with cotton.

India Paper.—Several kinds of paper manu-

factured by the Chinese evince, says Dr. Ure, 'the greatest art and ingenuity, and are applied with much advantage to many purposes. One especially, manufactured from the inner bark of the bamboo, is particularly celebrated for affording the clearest and most delicate impressions from copper plates, which are ordinarily termed India proofs. The Chinese, however, make paper of various kinds, some of the bark of trees, especially the mulberry-tree and the elm, but chiefly of the bamboo and cotton tree, and occasionally from other substances, such as hemp, wheat, or rice straw. To give an idea of the manner of fabricating paper from these different substances, it will suffice (the process being nearly the same in each) to confine our observations to the method adopted in the manufacture of paper from the bamboo—a kind of cane or hollow reed, divided by knots, but larger, more elastic, and more durable than any other reed. The whole substance of the bamboo is at times employed by the Chinese in this operation, but the younger stalks are preferred. The canes, being first cut into pieces of four or five feet in length, are made into parcels, and thrown into a reservoir of mud and water for about a fortnight, to soften them; they are then taken out and carefully washed, every one of the pieces being again cut into filaments, which are exposed to the rays of the sun to dry and to bleach. After this they are boiled in large kettles, and then reduced to pulp in mortars, by means of a hammer with a long handle; or, as is commonly the case, by submitting the mass to the action of stampers, raised in the usual way by cogs on a revolving axis. The pulp being thus far prepared, a glutinous substance extracted from the shoots of a certain plant is next mixed with it in stated quantities, and upon this mixture chiefly depends the quality of the paper. As soon as this has taken place, the whole is again beaten together until it becomes a thick viscous liquor, which, after being reduced to an essential state of consistency by a further admixture of water, is then transferred to a large reservoir or vat, having on each side of it a drying stove, in the form of the ridge of a house, that is, consisting of two sloping sides touching at top. These sides are covered externally with an exceedingly smooth coating of stucco, and a flue passes through the brickwork, so as to keep the whole of each side equally and moderately warm. A vat and a stove are placed alternately in the manufactory, so that there are two sides of two different stoves adjacent to each vat. The workman dips his mould, which is sometimes formed merely of bulrushes, cut in narrow strips and mounted in a frame, into the vat, and then raises it out again, the water passing off through the perforations in the bottom, and the pulpy paper-stuff remaining on its surface. The frame of the mould is then removed, and the bottom is pressed against the sides of one of the stoves, so as to make the sheet of paper adhere to its surface, and allow the sieve (as it were) to be withdrawn. The moisture, of course, speedily evaporates by the warmth of the stove, but before the paper is quite dry it is brushed over on its outer surface with a size made of rice, which also soon dries, and the paper is then stripped off in a finished state, having one surface exquisitely smooth, it being seldom the practice of the Chinese to write or print on both sides of the paper. While all this is taking place, the moulder has made a second sheet, and pressed it against the side of the other stove, where it undergoes the operation of sizing and drying precisely as in the former case.'

In the Preface to the *Calendars of the Exchequer*, published by the Record Commission, it is stated that 'some of the letters addressed to Hugh le Despencer, from Gascony (at various periods in the reign of Edward II.), are written on very stout and beautiful vellum; others on paper of a sound and strong fabric, well sized, and such as may altogether be called a good article. And although in the Tower there are a few letters upon cotton paper, yet parchment or vellum was generally used; and these are amongst the earliest examples of any continued correspondence upon the more commodious material, which in England was very rarely employed. It is highly probable that, in the South of France, the supply was received from the Moorish merchants or manufacturers of Spain.' 'The original register of the privy seal of Edward the Black Prince from July, 20 Edw. III., to January, 21 Edw. III., forming one volume, is on paper.'

Modern Paper Manufacture.—The precise period at which the manufacture of paper was introduced into Europe appears to be rather a matter of uncertainty. Paper-mills moved by water power were in operation in Tuscany at the beginning of the fourteenth century; and at Nuremberg one was established in 1390 by Ulman Stromer, who wrote the first work ever published on the art of paper-making. He seems to have employed a great number of persons, all of whom were obliged to take an oath that they would not teach any one the art of paper-making, or make it on their own account. In the following year, when anxious to increase the means of its production, he met with such strong opposition from his workmen, who would not consent to any enlargement of the mill, that it became at length requisite to bring them before the magistrates, by whom they were imprisoned, after which they submitted by renewing their oaths. Two or three centuries later, we find the Dutch, in like manner, so extremely jealous with respect to the manufacture, as to prohibit the exportation of moulds, under no less severe a penalty than that of death.

It is a commonly received opinion that the first paper mill was erected in England during the reign of Elizabeth; though it has been asserted that the first mill was set up in the reign of Charles I., by a German of the name of Sir John Spilman or Spielman, and that

the king granted him a patent, with a salary of 200*l.* a year. Both these opinions are proved to be erroneous by an entry in the privy purse expenses of Henry VII., dated May 25th, 1498, published in the *Excerpta Historica*, 'For a rewarde geven at the paper mylne, 16*s.* 8*d.*,' which establishes with certainty an anterior date of full fifty years. This mill is supposed to have been erected at Stevenage, in Hertfordshire, by John Tate. Dr. Dibdin gives this account of Spilman on the authority of Dr. Harris; but the statement is invalidated by Mr. Nicholls, in his *Progresses of Queen Elizabeth*, who has reprinted in that work a poem of the date 1588, of which the following is the title: *A Description and playne Discourse of Paper, and the whole Benefitts that Paper brings, with Rehearsall, and setting foorth in Verse a Paper-myll built near Darthford, by an high Germaine, called Master Spilman, Jeweller to the Queene's Majestie*, 1588. The magnitude of Spielman's establishment may be gathered from the lines:

> Six hundred men are set to work by him,
> That else might starve or seek abroad their bread,
> Who now live well, and go full brave and trim,
> And who may boast they are with paper fed.

In Scotland, in 1695, a company was formed for the manufacture of 'white writing and printing paper;' the original 'Articles concluded and agreed upon at a general meeting at Edinburgh, the 19th day of August,' are preserved in the British Museum. Perhaps no other manufacture ever remained so long nearly stationary; in fact, says Fairbairn (*Mills and Millwork*, vol. ii. p. 241), 'little was done in the way of perfection till the middle of the last and the beginning of the present century. Up to the latter period the only machinery then in use was the rag engine, and the moulds and felts as practised by hand in single sheets from the liquid pulp. It is a curious fact that, notwithstanding that paper has been made in this country and other parts of Europe from two to three centuries, few if any improvements till of late have been effected in the shape of machinery for the purpose of increasing the quantity and reducing the cost of the manufacture.'

Such, then, says Dr. Ure, 'was the rude state of this important manufacture, even up to the commencement of the present century, when a small working model of a continuous machine was introduced into this country from France by Mr. John Gamble, a brother-in-law of M. Leger Didot, the proprietor at that time of the paper manufactory at Essonne. The individual to whose genius we owe that beautiful contrivance, which has since been adopted wherever the want which it was designed to remedy has been truly felt, and which has contributed in an eminent degree to the advancement of civilisation, was an unassuming clerk in the establishment of M. Didot, named Louis Robert, who, following his favourite pursuit of inventing and improving, not unfrequently had to bear the reproach of wasting time on an invention that could never be brought to perfection. Fortunately, however, the patience and attention of this persevering man were at length sufficiently rewarded by the completion of a small model not larger than a bird organ, which enabled him to produce paper of a continuous length, although but the width of a piece of tape. So successful was this performance, that his employer, instead of continuing to thwart his progress, was now induced to afford him the means of making a model upon a larger scale, and in a few months a machine was completed capable of making paper the width of Colombier (twenty-four inches), for which the consumption in France was very great. After a series of experiments and improvements, Louis Robert applied to the French government for a patent or brevet d'invention, which he obtained in 1799 for a term of fifteen years, and was awarded the sum of 8,000 francs as a reward for his ingenuity. The specification of this patent is published in the second volume of the *Brevets d'Inventions Expirés*. Shortly afterwards M. Didot purchased Louis Robert's patent and paper machine for 25,000 francs, to be paid by instalments; but not fulfilling his engagements, the latter commenced legal proceedings, and recovered possession of his patent, by a decision dated June 23, 1801. Towards the close of the year 1800 M. Didot proposed to his brother-in-law, Mr. Gamble, that patents should be taken out in England, and suggested that he being an Englishman, and holding a situation under the British government, would in all probability accomplish it without much difficulty. To this proposition Mr. Gamble assented, and in the month of March, 1801, he left Paris for London, where, happily for the vigorous developement of this project, he obtained an introduction immediately upon his arrival to one of the principal wholesale stationery houses in Great Britain—a firm of considerable opulence—and to those gentlemen he mentioned the nature and circumstances of his visit, at the same time showing them several rolls of the paper of great length, which had been made at Essonne by Robert's machine, and which induced them to take a share in the patent.

'The firm alluded to was that of the Messrs. Fourdrinier—a name which has indeed become alike famous and unfortunate—and this transaction it was which first connected them with the paper machine. In the year 1801 Mr. Gamble returned to Paris, and concerted measures with M. Leger Didot and Louis Robert, to have the working model, which was then at Essonne, sent over to England to enable him to assist in the construction of other machines; and the following year M. Didot arriving in London was introduced by Mr. Gamble to the Messrs. Fourdrinier, when a series of experiments for improving the machine was at once commenced. But in order to accomplish the arduous object which the latter gentlemen then had in view, they laboured without intermission for nearly six years, when, after incurring an expense of 60,000*l.*, borne exclusively by them, they at length succeeded in giving some further

organisation and connection to the mechanical parts, for whi[illegible] likewise obtained a patent, and [illegible] eventually that there was little prospect of being recompensed for labour and risk, or even reimbursed their expenses, unless parliament should think proper to grant an extension of the patent, they determined upon making a fresh application to the legislature for that purpose. But it would appear that, although in the bill, as it passed the House of Commons, such prolonged period extended to fourteen years, in the Lords it was limited to seven, with an understanding that such term should be extended to seven years more in the event of the patentees proving, upon a future application, that they had not been sufficiently remunerated. No such application, however, was made, in consequence of a standing order of the House of Lords, placed on their journal subsequently to the passing of the Act. This regulation had the effect of depriving the Messrs. Fourdrinier of any benefit whatever from the invention; and ultimately, so great were the difficulties they had to encounter, and so little encouragement or support did they receive, that the time and attention required to mature this valuable invention, and the large capital which it absorbed, were the means of reducing those wealthy and liberal men to the humiliating condition of bankruptcy.'

The application of paper to the purposes of writing and printing, and the fact of its being indispensable to the prosecution of the latter, render its manufacture of the highest utility and importance. But, even in a commercial point of view, its value is very considerable. France, Holland, and Genoa had, for a lengthened period, a decided superiority in this department. As the finest and best paper is made of linen rags, its quality may be supposed to depend, in a considerable degree, on the sort of linen usually worn in the country where it is manufactured; and this circumstance is said to account for the greater whiteness of the Dutch and Belgian papers as compared with those of the French and Italians, and still more of the Germans. The rags used in the manufacture of writing paper in Great Britain are collected at home; but those used in the manufacture of the best printing paper are imported principally from Franco, Italy, Hamburg, and the Austrian States.

We believe that it was owing rather to want of skill than, as has sometimes been supposed, to the inferior quality of the linen of this country, that the manufacture of paper was not carried on with much success in England till a comparatively recent period. During the greater part of the seventeenth century our supply was chiefly imported from the Continent, especially from France. The manufacture of fine writing paper is said to have been considerably improved by the French refugees who fled to this country in 1685. But it is distinctly stated in the *British Merchant* (vol. ii. p. 266), that hardly any sort of paper, except brown, was made here before the Revolution. In 1690, however, the manufacture of white paper was attempted; and, within a few years, most branches were much improved. In 1721 it is supposed that there were about 300,000 reams of paper annually produced in Great Britain, which was equal to about two-thirds of the whole consumption.

	lbs.
In 1835 the weight of manufactured paper that had paid duty was . . .	70,000,000
In 1845 it had risen to . .	124,247,071
In 1855 „ „ . .	166,776,394
In 1859 „ „ nearly	218,000,000
And in six years more it may reach	300,000,000

In 1808, the price of rags, owing to the Continental war, was 7*d.* per lb.; and the following singular announcement was published in the *European Magazine* for October of that year: 'Porters, and others who have the charge of sweeping shops and public offices, are desired not to burn or destroy any coverings of letters, or any other waste paper, either printed or written (let the pieces be ever so small), as they can be re-manufactured; and the saving them will not only increase the quantity of paper, but be a handsome perquisite to themselves.'

In 1813 Dr. Colquhoun estimated the value of paper annually produced in Great Britain at 2,000,000*l.*; but Mr. Stevenson, an incomparably better authority upon such subjects, estimated it at only half this sum. Many thousand persons are supposed to be directly engaged in the trade; and, besides the workmen employed in the mills, the paper manufacture creates a considerable demand for the labour of millwrights, machinists, smiths, carpenters, iron and brass founders, wire-workers, woollen manufacturers, and others in the machinery and apparatus of the mills. Some parts of these are very powerful, and subject to severe strain, while other parts are complicated and delicate, and require continual renovation.

Such is the importance of this branch of industry, that to every appearance its increase is circumscribed only by the supply of the materials employed in the manufacture.

The annual consumption of rags in this country alone exceeds 120,000 tons, three-fourths of which are imported, Italy and Germany furnishing the principal supplies.

We pass on from this brief account of the history and statistics of paper to the mechanical process of its production; only remarking that many articles have been resorted to in its manufacture: 'Silks, woollens, flax, hemp, and cotton,' says Dr. Ure, 'in all their varied forms, whether as cambric, lace, linen, holland, fustian, corduroy, bagging, canvas, or even as cables, are or can be used in the manufacture of paper of one kind or another. Still, rags, as of necessity they accumulate and are gathered up by those who make it their business to collect them, are very far from

answering the purposes of paper-making. Rags to the paper-maker are almost as various in point of quality or distinction as the materials which are sought after through the influence of fashion. Thus the paper-maker, in buying rags, requires to know exactly of what the bulk is composed. If he is a manufacturer of white papers, no matter whether intended for writing or printing, silk or woollen rags would be found altogether useless, inasmuch, as is well known, the bleach will fail to act upon any animal substance whatever. And although he may purchase even a mixture in proper proportions, adapted for the quality he is in the habit of supplying, it is essential, in the processes of preparation, that they shall previously be separated. Cotton in its raw state, as may be readily conceived, requires far less preparation than a strong hempen fabric; and thus, to meet the requirements of the paper-maker, rags are classed under different denominations, as, for instance, besides fines, and seconds, there are thirds, which are composed of fustians, corduroy, and familiar fabrics; stamps or prints (as they are termed by the paper-maker), which are coloured rags, and also innumerable foreign rags, distinguished by certain well-known marks, indicating their various peculiarities. It might be mentioned, however, that, although by far the greater portion of the materials employed are such as have been already alluded to, it is not from their possessing any exclusive suitableness—since various fibrous vegetable substances have frequently been used, and are, indeed, still successfully employed—but rather on account of their comparatively trifling value, arising from the limited use to which they are otherwise applicable.' The same writer goes on to state, that 'almost every species of tough fibrous, vegetable, and even animal substance, has at one time or another been employed; even the roots of trees, their bark, the bine of hops, the tendrils of the vine, the stalks of the nettle, the common thistle, the stem of the hollyhock, the sugar-cane, cabbage stalks, beet-root, wood shavings, sawdust, hay, straw, willow, and the like.' The works of the marquis de Villette, published in London, 1786, in 24mo., are printed on paper made of marshmallow; and at the end are specimens, in single leaves, of paper made from the nettle, hops, moss, reed, three of three species of confervæ, couch grass, spindle trees, wayfaring tree, elm, lime tree, yellow willow, sallow willow, poplar, oak, two of burdock, coltsfoot, and thistle.

'All,' says Dr. Ure, 'that can be said of the suitableness of fibre in general, may be summed up in a very few words; any vegetable fibre having a corrugated edge, which will enable it to cohere in the mass, is fit for the purpose of paper-making: the extent to which such might be applied can solely be determined by the question of cost in its production, and hitherto everything which has been proposed as a substitute for rags has been excluded either by the cost of freight, the cost of preparation, or the expenses combined.'

Straw Paper.—Straw is occasionally used, in connection with other materials, such as linen or cotton rags, and even with considerable advantage, provided the processes of preparation be thoroughly understood.'

With all the drawbacks attending the preparation of straw, there is certainly no fibre to compete with it at present as an auxiliary to that of rags. A thick brown paper, of tolerable strength, may be made from it cheaply; but for printing or writing purposes only an inferior description can be produced, and of little comparative strength to that of rag paper. Its chief and best use is that of imparting stiffness to common newspaper. Some manufacturers prefer for this purpose an intermixture of straw with paper shavings, and others in place of the paper shavings give the preference to rags. The proportion of straw used in connection with rags or paper shavings varies from 50 to 80 per cent.

The cost at the present time of producing two papers of equal quality, one entirely from straw, and the other entirely from rags, would be very nearly equal; for although the cost of the rags would be at least 17*l.* per ton, and the cost of the straw not more than 2*l.* per ton, in addition to the greatly increased cost of preparing the straw, the rags would only waste one-third, while the straw would waste fully one-half. Thus, taking into consideration the waste which each undergoes in process of preparation, the actual cost of material in producing a ton of paper may be stated relatively as 25*l.* for rags, and 4*l.* for straw. But as the cost of preparation, which includes power, labour, and chemicals, is so much greater in the case of the straw—from two to three times as much as that of rags—a similarity of value is thus ultimately attained. 'In order to reduce the straw to a suitable consistency for paper-making, it is placed in a boiler, with a large quantity of strong alkali, and with a pressure of steam equal to 120 lbs. and sometimes to 150 lbs. per square inch; the extreme heat being attained in super-heating the steam after it leaves the boiler, by passing it through a coiled pipe over a fire, and thus the silica becomes destroyed, and the straw softened to pulp, which after being freed from the alkali by washing it in cold water, is subsequently bleached and beaten in the ordinary rag engine, to which we shall presently refer.

Wood Paper.—'Two inventions have been patented for manufacturing paper entirely from wood. One process consists in first boiling the wood in caustic soda lye, in order to remove the resinous matter, and then washing to remove the alkali; the wood is next treated with chlorine gas or an oxygenous compound of chlorine in a suitable apparatus, and washed to free it from the hydrochloric acid formed; it is now treated with a small quantity of caustic soda, which converts it instantly into

which has only to be washed and bleached, when it will merely require to be beaten for an hour or an hour and a half in the ordinary beating engine, and made into paper. The other invention is very simple, consisting merely of a wooden box enclosing a grindstone, which has a roughened surface, and against which the blocks of wood are kept in close contact by a lever, a small stream of water being allowed to flow upon the stone as it turns, in order to free it of the pulp, and to assist in carrying it off through an outlet at the bottom. Of course, the pulp thus produced cannot be employed for any but the coarser kinds of paper. For all writing and printing purposes, which, manifestly, are the most important, nothing has yet been discovered to lessen the value of rags, neither is it at all probable that there will, inasmuch as rags, of necessity, must continue accumulating, and before it will answer the purpose of the paper-maker to employ new material, which is not so well adapted for his purpose as the old, he must be enabled to purchase it for considerably less than it would be worth in the manufacture of textile fabrics; and, besides all this, rags possess in themselves the very great advantage of having been repeatedly prepared for paper-making by the numerous alkaline washings which they necessarily receive during their period of use.'

The rags in the London market are sold to the manufacturers according to their respective quality, the principal sorts being known as fine, second, and third English rags; and SPFF, SPF, FF, foreign rags, of which, however, there are numerous other marks or brands according to the country or port from which they come. The finest writing papers are made principally of linen rags, but cotton enters more or less into the composition of most printing papers. Even the strong coarse bags in which the rags are packed, and the coloured rags, may, by improved processes in bleaching, be rendered available for white papers. Of late years a considerable quantity of common printing paper has been manufactured from straw, and the esparto or Spanish grass, a fibrous grass which grows in abundance in some of the sandy tracts by the sea-shore in Spain, has also been successfully employed in the manufacture of the cheaper qualities of printing paper. It is necessary that these rags should be dusted; and, to accomplish this, they are placed in a cylinder formed of wire net, turning on pivots at each end, and enclosed in a box which receives the dust as it falls through the net-work; their sorting then takes place over a table frame covered with wire net, through which the dust falls into a box beneath as the workwoman proceeds in her labours. In sorting, rags are cut into pieces not exceeding three or four inches square, the parts that have seams being thrown into a separate heap, as dirt so frequently lurks in these seams. In this process the rags are scrupulously sorted according to their texture and degree of strength, not according to their colour; for, were they not carefully arranged by this rule, the fine in texture would be reduced to a pulp long before the coarse, and be lost in the preparation; or, if preserved, when reduced to pulp, would not be found of the same consistency as the coarser sorts, and the paper when manufactured would necessarily be clouded and inferior. It is for these reasons that this part of the process is important. When they have been carefully sorted, and the different degrees of texture have, by a longer or shorter process, been reduced to a pulp of similar consistency, they may then be mixed together; but this cannot be previously done. While in this state the rags often appear so dirty and discoloured as to preclude all hope, to an inexperienced eye, that they can ever assume the purity of that beautiful fabric so valuable to the artist and the scribe. The rags are at first worked coarsely with a stream of water running through the engine, which tends effectually to wash them, as also to open their fibres; and in order to carry off the dirty water, what is termed a *washing drum* is frequently employed, consisting of a framework covered with very fine wire gauze, in the interior of which, connected with the shaft or spindle, which is hollow, are two suction tubes; and thus, on the principle of the siphon, the dirty water constantly flows away through a larger tube running down outside and connected with that in the centre, without carrying away any of the fibre. In former times the process of *gas-bleaching*, or exposing the rags to the action of chlorine gas in a close stone-chamber, was much used. Of late, however, the bleaching of the rags is effected by steeping them in a solution of chloride of lime. The rags, after being washed, are usually emptied into a receiver, which can be placed under a hydraulic press, and are thus deprived of any superfluous moisture. They are then usually passed through a *sifter* or *duster* so as to remove any extraneous matter as far as possible, after which they are mixed with a solution of chloride of lime in a *potcher-engine*, and then left to bleach in the steeping bins, from which the liquor can be drawn off after the bleaching process is complete. After this process they are put into the beating engines, and pass through a sort of trituration, which reduces them to a coarse and imperfect pulp, which is called half stuff or first stuff, and this is again levigated until it assumes the appearance of cream. The introduction of colouring matter is accomplished by its intermixture with the pulp while in process of beating in the engine. Ultramarine is much used for bluing paper; but smalt, or oxide of cobalt, is used for some writing papers, and imparts a more lasting colour than ultramarine.

The state and quality of this pulp is of the utmost importance to the final perfection of the paper. If, in the levigation, the fibre should have been so entirely destroyed as to

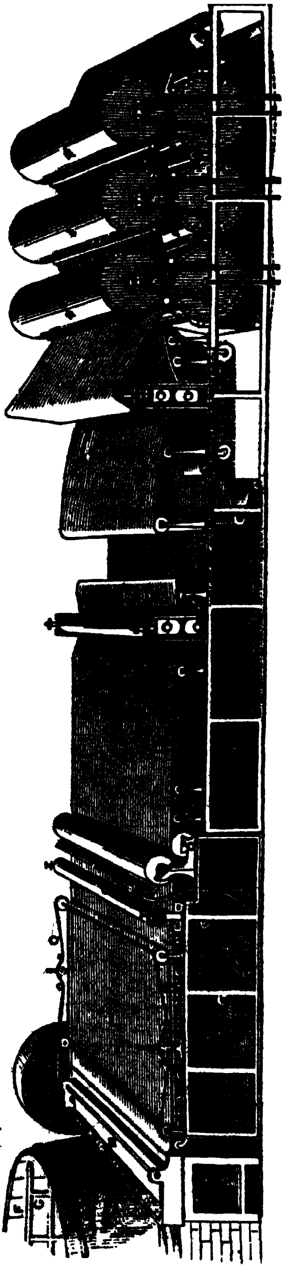
rêduce it to a powder, the paper will inevitably prove liable to break, moulder away, and be rotten; and this must be the result, whatever may have been the previous excellence of the material. A fibre is absolutely necessary to the production of a serviceable paper. But, unfortunately, so far from efforts being made to improve its consistency, means are resorted to for the sake of an increased profit, which deteriorate it almost to destruction: we mean the introduction of plaster of Paris, or other earthy substances, into the pulp; and this can never be done without insuring brittleness and want of cohesion as the result. While the pulp is in this state, the size, now usually made from saponified resin, is introduced; excepting only in the manufacture of writing paper, and then the sheets are most generally sized after their formation.

Having described the preparation of the pulp, we shall pass on to its formation into paper; which operation may be divided into two kinds, hand-made and machine-made paper. In the former case, the fine pulp, or stuff, as it is technically called, is transferred into a chest or large tub with a revolving agitator; thence into a vat, usually about five feet in diameter, and two and a half feet in depth, and sustained at a proper temperature by means of During the whole of the subsequent process it is requisite that the pulp in the vat should be stirred up at short intervals, to keep it of an equal consistency. There are three workmen employed in this stage of the operation, called the *vatman* or *dipper*, the *coucher*, and the *lifter*. The dipper is provided with a mould, formed of well-seasoned mahogany, across which parallel wires are stretched close together, a few other stronger ones being also placed at right angles with them, and at some distance from each other. The lines formed in the paper by these wires are called *water-marks*; but, in the modern improvement of wove paper, these are avoided by using wire cloth woven in a loom, which, being tightly stretched over the frame, produces no water-mark. This mould is provided with another frame, called a *deckle*, which fits it exactly, and forms a boundary line to the sheet of paper, which would otherwise have a rough and jagged edge. This contrivance, by supplying an edge to the mould, gives it the character of a sieve, which enables the dipper (after he has dipped the mould into the vat, and taken in a sufficient quantity of the pulp, and given it a gentle motion to equalise its thickness) to drain the water away; he then removes the deckle, replaces it on another mould, and proceeds as before; whilst the second workman, the coucher, removes the sheet of paper thus made on to a felt, being a piece of woollen cloth, and then returns the mould to the dipper, who, in the meantime, has been operating with another mould, and forming another sheet: they thus exchange the moulds, the one dipping, and the other couching, until they have completed six quires of paper, which is called a *post*. When this quantity is completed, the heap is conveyed to the vat press, and subjected to heavy pressure. The six quires remain in the vat press until the dipper and the coucher have perfected another post, when they are removed to give place to it; and then the office of the third workman, the lifter, commences. He separates the sheets of paper from the felts, and forms them into a pile, which is again subjected to a second press, which detaches from them a great quantity of moisture. Here it remains until the workmen are prepared to replace it with a similar quantity, when it is taken to the drying rooms, and hung up on lines to dry. These lines are carefully covered with wax, both to prevent adhesion and contraction; and the opening of the windows should be strictly attended to, that the drying may not proceed too rapidly. This being accomplished, it is taken down, shaken, to make the dust fall out, and to separate the sheets from each other, and laid up in heaps ready to be sized. The size is prepared of a due consistence, twice filtered, and a portion of alum added. The workman dips a handful of the sheets, holding them open at the edges, that they may more equally imbibe the moisture, and after this process they are again subjected to the press. They are afterwards dried, sorted, brought under repeated and excessive pressure, and finally made up into quires and reams.

But as the process of paper-making must necessarily be comparatively slow when practised by hand, machinery (described above) has been resorted to. One of these machines can produce an enormous length of paper per minute; and it is this which enables us to enter into competition with the foreign market, which we could not otherwise do, on account of the difference in the value of manual labour. In the old method, it took three months after receiving the rags into the mill to complete the paper: by the machine, they can receive the rags on one day, and deliver the paper made from them on the next.

The stuff, having been prepared and bleached in an expeditious manner by machinery, is emptied into the *chest* or tub, F, as before, and thence is delivered gradually into the vat, where it is kept in continual motion by means of revolving fans, called *hogs*, G. The pulp is conveyed from this reservoir by a *lifter*, H, a cast-iron wheel in a wooden case having a number of buckets affixed to its circumference. The trough, I, placed beneath the endless wire, K, is for the purpose of receiving the water which drains away from the pulp during the process of manufacture, and this water is returned by a conducting spout to the lifter, where by a rotation of the buckets both the pulp and back-water become again thoroughly mixed, and are raised by the lifter through the spout, L, into the trough, M, where the pulp is strained by means of a sieve or *knotter*. The long cascade or continuous stream of pulp, regulated with reference to the proposed thickness of the paper to be made, gently

descends on the moving wire plane, which is perpetually travelling onward and onward

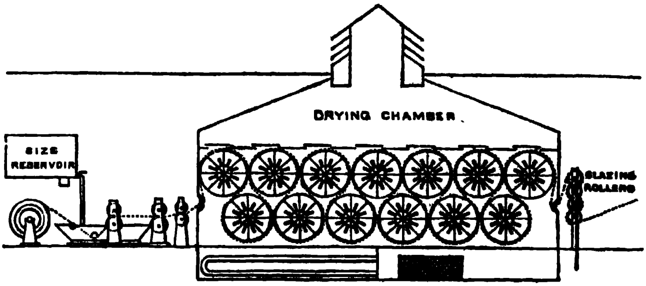


and, for its more perfect equalisation, a second movement is resorted to, by means of a sort of crank, which gives the web a gentle vibratory motion at short intervals, and diffuses the liquid pulp evenly over the surface. At the end nearest to the trough the pulp is, of course, perfectly fluid; but, as the web travels on, the moisture partially sinks through the fine apertures of the webbing, and the material coagulates. There has been a fashion prevalent of late years of having paper *barred* or *laid*: this appearance is given at this juncture. While yet moist, just before passing from the wire webbing, it is subjected to the pressure of a wire roller, which gives the indentations of the stripes or lines; this cylinder is called a *dandy* roller, P; it is received off this from the wire gauze by a continuous felt, S, which conducts it through two pairs of *pressing rollers*. This process answers to the wet press in the hand-made paper; and formerly this was the termination of the labours of the machines, the remaining work of drying, &c. being accomplished by hand. But an incalculable improvement was achieved by the addition of the drying rollers. These are cylinders of polished metal, which effect in a few moments the perfect drying of the paper. While yet moist, the paper passes over the first, moderately warm, heated by injected steam; again over the second, of larger diameter, of greater warmth; and again over the others, with an augmented heat. The paper is now perfectly dry, and, passing over the glazing rollers, its manufacture is completed. The final action of this wonderful machine is to wind the paper round a last roller or *reel*, which when full is exchanged for another, and so on successively. If the paper is intended for printing purposes, it can be *sized* sufficiently in the pulp, by an admixture of alum, soda, and resin, or the like; but if it is to serve as writing paper, it has to undergo a more effectual method of sizing; the size in this case being parings obtained from tanners, curriers, and parchment makers, as employed in the case of hand-made papers. Animal size, which is essential for all good writing papers, cannot at present be employed in the process of manufacturing paper by the machine without injury to the felts, and it therefore becomes necessary to pass the web of paper, after it has been dried by the cylinders, through the size reservoir and thence over the skeleton drums of the drying chamber, as shown in the figure.

Here the work of the machine is finished, and the paper, being in long webs of many yards, requires to be cut into sheets. After different methods had been tried, a supplementary machine was invented, which receives the web from off the reel on to a drum, cuts it into sheets of proper lengths with a circular knife, continually revolving, while the divided web proceeds; and these sheets are received and placed in regular heaps by children.

The manufacture of the paper being thus completed, the sheets are separately examined,

and every knot or blemish carefully removed, the torn or damaged ones being laid apart. In this state they are subjected to the action of a powerful press, in the full and open size of the sheet: they are then counted into quires of twenty-four sheets, which are folded in the middle, and put into reams, each ream containing twenty quires, of which the two on the outside are made up of twenty sheets each from the damaged sheets that were thrown out. In this state they are again pressed, and finally tied up in coarse paper wrappers. These wrappers were formerly stamped by the exciseman; the Act 6 & 7 Wm. IV. c. 52 charging the paper with an excise duty of three halfpence a pound.



Although the machinery of a paper mill will sometimes reach to a length of a thousand feet, the quantity of machinery (says Dr. Fairbairn) is not considerable when compared with mills for the manufacture of the textile fabrics; and, with the exception of the paper machine, the drying, cutting, and sizing machines, a mill for the manufacture of paper, so far as its mechanism is concerned, is almost exclusively a piece of well-constructed millwork. The other parts of the manufacture belong to the chemist, both before and after the mechanical operations have been effected.

Blotting paper, filtering paper, and the like, are rendered absorbent by the free use of *woollen* rags and the absence of size.

Rice paper is not an artificial production. [Rice Paper.]

Connected with the manufacture of paper, says Dr. Ure, 'there is one point of considerable interest and importance, and that is what is commonly, but erroneously, termed the *water-mark*, which may be noticed in the *Times* newspaper, Bank of England notes, cheques, and bills, as also in every postage and receipt label of the present day. Water-marks have at various periods been the means of detecting frauds, forgeries, and impositions, in our courts of law and elsewhere, to say nothing of the protection they afford in the instances already referred to, such as bank notes, cheques, receipt, bill, and postage stamps. The celebrated Curran once distinguished himself in a case which he had undertaken, by shrewdly referring to the water-mark, which effectually determined the verdict. And another instance occurred at Messina, where the monks of a certain monastery exhibited, with great triumph, a letter as being written by the Virgin Mary with her own hand. Unluckily for them, however, this was not, as it easily might have been, written upon the ancient papyrus, but on paper made of rags. On one occasion a visitor, to whom this was shown, observed, with affected solemnity, that the letter involved also a miracle, for the paper on which it was written was not in existence until several centuries after the death of the Virgin.'

The various sizes of paper have, in some instances at least, derived their names from the water-marks used at the periods of their manufacture. Thus *pot*, from the mark of the jug, in paper manufactured in 1540-1560; *foolscap*, a later device; *post*, from a post-horn, about 1670. The water-mark in Caxton's *Game and Playe of the Chesse*, and common in works printed by him, was a letter p surmounted by a star.

The perfection to which water-marks have been brought is shown by the following mode, quoted from Dr. Ure, and adopted by the Bank of England: 'To produce a line water-mark of any autograph or crest, we might either engrave the pattern or device first in some yielding surface, precisely as we should engrave a copper-plate for printing, and afterwards, by immersing the plate in a solution of sulphate of copper, and electrotyping it in the usual way, allow the interstices of the engraving to give as it were a casting of pure copper, and thus an exact representation of the original device, which, upon being removed from the plate, and affixed to the surface of the wire-gauze forming the mould, would produce a corresponding impression in the paper: or, supposing perfect identity to be essential, as in the case of a bank note, we might engrave the design upon the surface of a steel die, taking care to cut those parts in the die deepest which are intended to give greater effect in the paper, and then, after having hardened, and otherwise properly prepared the die, it would be placed under a steam hammer or other stamping apparatus, for the purpose of producing what is technically termed a *force*, which is required to assist in trans-

ferring an impression from the die to a plate of sheet brass. This being done, the die, with the mould-plate in it, would next be taken to a perforating or cutting machine, where the back of the mould-plate—that is, the portion which projects above the face of the die—would be removed, while that portion which was impressed into the design engraven would remain untouched, and this being subsequently taken from the interstices of the die and placed in a frame upon a backing of fine wire-cloth, becomes a mould for the manufacture of paper of the pattern which is desired, or for the production of any water-mark, autograph, crest, or device, however complicated.

'Light and shade are occasioned by a very similar process, but one which perhaps requires a little more care, and necessarily becomes somewhat more tedious. For instance, in the former case the pulp is distributed equally throughout the entire surface of the wire forming the mould, whereas *now* we have to contrive the means of increasing to a very great nicety the thickness or distribution of the pulp, and at the same time to make provision for the water's draining away. This has been accomplished by first taking an electrotype of the raised surface of any model or design, and again, from that, forming in a similar manner a matrix or mould, both of which are subsequently mounted upon lead or gutta percha, in order that they may withstand the pressure which is required to be put upon them in giving impression to a sheet of very fine copper wire-gauze, which, in the form of a mould, and in the hands of the vatman, suffices ultimately to produce those beautiful transparent effects in paper pulp. The word *Five* in the centre of the Bank of England note is produced in the same manner; the deepest shadows in the water-mark being occasioned by the deepest engraving upon the die, the lightest by the shallowest, and so forth; the die being employed to give impression by means of the stamping press and *force* to the fine wire-gauze itself, which by this means, provided the die be properly cut, is accomplished far more successfully than by any other process, and with the additional advantage of securing perfect identity.

'It may be interesting to call attention to the contrast as regards the method of mould-making originally practised, and that which has recently been adopted by the Bank of England. In a pair of five-pound note moulds, prepared by the old process, there were 8 curved borders, 16 figures, 168 large waves, and 240 letters, which had all to be separately secured by the finest wire to the waved surface. There were 1,056 wires, 67,584 twists, and the same repetition where the stout wires were introduced to support the under surface. Therefore, with the backing, laying, large waves, figures, letters and borders, before a pair of moulds was completed, there were some hundreds of thousands of stitches, most of which are now avoided by the new patent. But further, by this multitudinous stitching and sewing, the parts were never placed precisely in the same position, and the water-mark was consequently never identical. Now, the same die gives impression to the metal which transfers it to the water-mark, with a certainty of identity unattainable before, and, one could almost say, never to be surpassed.'

Paper may be divided into *three* classes: writing, printing, and wrapping; the former into *five* divisions, viz. cream wove, yellow wove, blue wove, cream laid, and blue laid; the printing into *two*, laid and wove; the wrapping into *four*—blue, purple, brown, and whited brown.

Indelible Cheque Paper has been patented at various periods during the last forty years for the purpose of affording obstacles to the fraudulent alteration of the amount and intent of bankers' cheques and drafts. One of the latest modes, that of Mr. Robert Barclay, is performed by a process of manufacturing a white writing paper on which writing ink is stated to be unalterable for fraudulent purposes by any existing chemical process. He incorporates in the paper an insoluble ferro-cyanide and an insoluble salt of manganese, and provides against the discolouration of the paper in the sizing process (which has been a serious objection in practice to the use of the ferro-cyanide of potassium) by discarding the use of alum, and sizing the paper by the acetate of alumina in lieu of it. Writing placed upon this paper strengthens in intensity when exposed to damp, sea air, or water, influences which ordinarily cause common writing ink to fade and become illegible. This paper has been examined and reported upon favourably by some of the most eminent scientific men of the day, but it has not been generally adopted.

The paper duty was first imposed, but only for two years, in 1696, during the reign of William III., and consisted of 20 per cent. ad valorem on English, and 25 per cent. on imported paper, parchment, and pasteboard. The 10th of Anne imposed the first tax upon newspapers and advertisements, and also a tax upon paper and foreign books, dividing paper into twelve qualities, taxing each according to its value. The first year it produced only 13,743*l*. 5*s*. 9*d*. (Bibles, Prayer-books, and Confessions of Faith were exempted). In 1803, paper was divided into only two qualities. The Act 6 & 7 Wm. IV. c. 52 imposed a uniform duty of 1½*d*. per pound, and the effect was to raise the revenue from this source from 790,777*l*. in 1836 to 1,244,723*l*. in 1857. In 1840 an additional 5 per cent. was imposed; but in 1861 the tax was repealed.

When the duty on paper was charged according to the size, the exact dimensions of the sheets was insisted upon; but when the mode of imposing the duty was changed from size to weight, the makers began to vary the size. The following table shows what the dimensions ought to be:—

	In.	In.
First Table.		
Imperial Writing	22	30¼
Super Royal do.	19¼	27¼
Royal do.	19¼	24
Medium do.	17¼	22¼
Demy do.	15¼	20
Thick and Thin Post	15¼	19¼
Foolscap	13¼	16¼
Post	12½	15½
Extra Large Post	16½	21
Second Table.		
Double Atlas	55	31½
Demy	15½	20
Copy or Bastard	16	20½
Foolscap	13½	16½
Litrias Foolscap	13½	17½
Pott	12½	15
Grand Eagle, or Double Elephant	26¾	40
Columbier	23½	34½
Atlas	26¼	34
Do. Small	25	31
Imperial	22	30½
Super Royal	19¼	27½
Long Royal	27½	18
Royal	19¼	24
Demy	17	22
Short Demy	14	20½
Crown	15	20
Large Fan	23½	20½
Small do.	22¼	13¼
Elephant	23	28
Third Table.		
Double Demy	26	38½
Royal do.	19½ 20	24¼ 26
Inferior Royal	19½	24¼
Medium	18	23
Demy, Single	17½	22
Demy, Single	19¼	21¼
Double Crown	20	30
Single do.	15	20
Demy Tissue	17½	22
Crown do.	15	20
Double Pott	17	25½
Fourth Table.		
Cartridge	21	26
Do. Square	24½	25½
Do.	19¼	24
Elephant, Common	23	28
Sugar, Blue	21¼	33
Do. do. Small	18¼	27
Do do. Demy size	17½	22
Do. do. Crown size	15	20
Purple, Royal	19½	24½
Blue Elephant	23	28
Do. Royal	19½	24½
Do. Demy	17	22
Do. Crown	15	20
Fifth Table.		
Royal Hand, thick	24	19¼
Royal Hand	24	19¼
Lumber Hand	23	18
Double Two-pound	24	16
Single do. do.	16	11
Middle Hand, double	33	21
Middle Hand	22	16
Small Hand, double	32	20
Small Hand	19¼	16
Couples, pound	12	10
Do. half pound	9	7½
Imperial Cap	29	22
Havon Cap	24	20
Bag Cap	23½	19
Kentish Cap	21	18
Four Pounds	20	16
Small Cap	20	15
Double Four Pounds	33	20
Single Two Pounds	16	12

Paper Coal. A peculiar variety of lignite, consisting of a bituminous shale, splitting readily into films or leaves not thicker than paper. This variety is chiefly found in Germany, near Bonn, at the base of the newer tertiary brown coals of that district. Not unfrequently a kind of polishing slate is found between the laminæ of the paper coal. This mineral being silica in an extremely fine state of division, is probably of contemporaneous origin, and has perhaps some reference to the nature of the deposit and the existence of this peculiar form of lignite.

Paper Hangings. This important and elegant substitute for the ancient *hangings* of tapestry or cloth came into use about two hundred years ago. The manufacture has been raised by a succession of improvements to a high state of perfection.

The paper is commonly printed or stained with wooden blocks. The blocks are prepared by the pattern being marked on the face, the remainder being cut away, or by small pieces of metal being in part inserted in the blocks. The paper is stained by the surface of the blocks being dipped in colour, and laid on the paper, which has been previously covered with a thin coat of colour. In the cheaper kinds of paper hangings, a coloured paper is used to print on.

By far the greater portion of paper hangings are now produced by steam machinery; the patterns are produced by inserting metal in cylinders, which are placed near each other. The paper is printed by being passed over or under the series of cylinders, which, being heated, dry the colours instantly, so that a long length of paper is put into the machine plain, and almost in an instant of time it comes out at the other side a length of finished paper hangings of a dozen or even twenty colours, fit to be hung. The papers are sometimes printed with varnish or size, and gilt or copper leaf applied; or bisulphide of tin (*aurum musivum*) is dusted over so as to adhere to the pattern; and in what are called *flock papers*, dyed wools minced into powder are similarly applied. Powdered steatite or French chalk is used as the ground for satin papers, the gloss being produced by the ground being rubbed or polished. Striped papers are sometimes made by passing the paper rapidly under a trough, which has parallel slits in its bottom, through which the colour is delivered; and a number of other very ingenious and beautiful contrivances have lately been applied in this important branch of art. The invention of the paper machine, by which any length of paper may be obtained, effected a great change in paper hangings, which could formerly only be printed upon separate sheets, and were much more inconvenient to print as well as to apply to the walls.

Paper Money. In Political Economy, this term is generally used to denote the issues of banks as well convertible as inconvertible. But some economists, and in particular the late Mr. Thomas Tooke, whose authority on all banking questions stands deservedly high, employed this expression in a peculiar sense for inconvertible paper only, using *circulating credit* to denote bills of exchange and securities analogous to them. [BANK; CURRENCY; EXCHANGE, BILL OF; MONEY.]

Paper Nautilus. [ARGONAUT.]

Papier Moure. Paper impregnated with a sweetened solution of arseniate of potash is used, under the above name, as a fly-poison.

Papier-mâché (Fr.). A name given to articles manufactured of the pulp of paper, or of old paper ground up into a pulp, with other materials, and moulded into various forms. This article has been used upon an extensive scale for the manufacture of mouldings, rosettes, and other architectural ornaments; pilasters, capitals, and even figures as large as life, have also been made of it. It is lighter, more durable, and less brittle and liable to damage than plaster, and admits of being coloured, gilt, or otherwise ornamented. Another material, similar to papier-mâché and extensively used, is called *carton pierre*. Another kind of papier-mâché consists of sheets of paper pasted or glued and powerfully pressed together, so as to acquire when dry the hardness of board, and yet to admit, while moist, of curvature and flexure; tea-trays, waiters, snuff-boxes, and similar articles are thus prepared, and afterwards carefully covered by japan or other varnishes, and often beautifully ornamented by figures or landscapes and other devices, &c., inlaid occasionally with mother of pearl. A mixture of sulphate of iron, quicklime, and glue, or white of egg, with the pulp for papier-mâché, renders it to a great extent waterproof; and the further addition of borax and phosphate of soda contributes to make it almost fireproof.

Papilio. [BUTTERFLY.]

Papilionaceæ. [LEGUMINOSÆ.]

Papilionaceous (Lat. papilio, *a butterfly*). In Botany, a name given to the corolla of leguminous plants, from its fancied resemblance to the figure of a butterfly. This form is seen in the garden pea and bean, and consists of a large upper petal or vexillum, two lateral petals called alæ, and two intermediate petals forming a carina.

Papilionidæ (Lat. papilio). The name of a family of Lepidopterous insects, of which the genus *Papilio* is the type. [BUTTERFLY; DIURNALS.]

Papillæ (Lat.). In Anatomy, minute conical or cylindriform elevations, usually well supplied with vessels and nerves: they are close-set, and prominent on the palmar surface of the fingers and the plantar surface of the toes, where they are disposed in double rows along parallel curved lines. They are very numerous, and of different kinds; e.g. *conical*, *fungiform*, *calyciform*, on the upper surface of the tongue.

Pappus (Lat.; Gr. πάππος). In Botany, a name given to the calyx of *Compositæ*, which exists in the rudimentary condition of a cup or membranous coronet, or in the more perfect state of slender hairs or scales, or in some other similar condition, at the top of the achene or fruit.

Papyri (Lat.; Gr. πάπυρος). The name given to the written scrolls, made of the *papyrus*, which have been found in various places, but more especially in Egypt and Herculaneum. The process of making papyri was as follows: The interior of the stalks of the plant, after the rind had been removed, was cut into thin slices in the direction of their length; these being laid on a flat board in succession, similar slices were placed over them at right angles; and their surfaces being cemented together by a sort of glue, and subjected to a proper degree of pressure, and well dried, the papyrus was completed. The length of the slices depended, of course, on the breadth of the intended sheet, as that of the sheet on the number of slices placed in succession beside each other; so that, though the breadth was limited, the papyrus might be extended to an indefinite length. Many of the papyri which have been preserved vary greatly in their texture and appearance: they are generally fragile, and difficult to unroll until rendered pliable by gradual exposure to steam or the damp of an English climate; and some are so brittle that they appear to have been dried by artificial means. (Sir G. Wilkinson's *Manners and Customs of the Ancient Egyptians*, vol. iii. pp. 147–8.) Much interest was excited by the discovery of the papyri rolls at Herculaneum; but after all the trouble that has been taken, little or nothing has been found worthy of the pains. All the deciphered papyri are contained in the work *Herculanensium Voluminum quæ supersunt*; *Edinburgh Review*, Oct. 1862.

Papyrin. A modification of paper formed on dipping it into sulphuric acid, washing, immersing in dilute ammonia, rewashing and drying. The product is tough and durable. It is commonly called *vegetable parchment*.

Papyrus. [PAPER.]

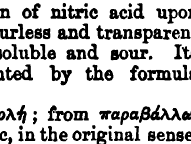
Par (Lat. *equal*). The most significant employment of this word is in relation to foreign exchanges [EXCHANGE, PAR OF]; but it is also familiarly used to denote the exact correspondence of a public security or stock with the sum which it represents. Thus a stock of 10*l*., 25*l*., or 100*l*. shares is said to be at par when the market price exactly equals the sum invested, and to be at a premium or a discount when the sale can be effected with some advantage to the holder, or cannot be effected without some loss. The price of an investment would always be at par provided it were absolutely safe, and no increase or diminution of its capital value was likely to occur. In other words, its market value would represent the ordinary rate of interest.

Para. A very small Turkish coin, equal to the fortieth part of a piastre.

Parabanic Acid. One of the acids resulting from the action of nitric acid upon uric acid; it forms colourless and transparent six-sided prisms, very soluble and sour. Its composition is represented by the formula $C_6O_4N_2 + 2HO$.

Parable (Gr. παραβολή; from παραβάλλω, *I compare*). In Rhetoric, in the original sense, a comparison; but the word is employed chiefly, in modern usage, to denote short tales, after the Oriental manner, in each of which, as in the parables of the New Testament, not only a moral or religious truth is conveyed, but the objects contained in the hidden sense are distinctly represented by parallel objects or types in the external narrative.

Parabola (Gr. παραβολή). In Geometry, one of the conic sections; formed, in fact, by the intersection of the cone with a plane parallel to one of its sides. Considered as a plane curve, the parabola may be defined as follows: A point F, and a straight line B B′, being given in position, let another point D be supposed to move in such a manner in the plane F B B′, that its distance D F from the given point is always equal to its distance D H from the given straight line: the point D will trace out the parabola.



The given line B B′ is called the *directrix* of the parabola; the given point F is the *focus*; the straight line F C, drawn through F perpendicular to the directrix, is the *axis*; any straight line H *h* parallel to C F is a *diameter*; the point in which the diameter meets the curve is the *vertex* of the diameter; and a straight line, quadruple the distance between the vertex of any diameter and the directrix, is called the *latus rectum* or *parameter* of that diameter.

From the preceding definition of the curve, its algebraic equation, referred to any tangent D T and the diameter D h through its point of contact, is easily found to be $y^2 = px$, where p is the parameter of that diameter. The square on any ordinate, therefore, is equal to the rectangle under the parameter and the corresponding abscissa—hence the name parabola. The polar equation of the curve, referred to the focus, is

$$4r \cos^2 \frac{\theta}{2} = p,$$

a particular form, therefore, of the general equation

$$r^n \cos n\,\theta = a^n.$$

Every *focal radius vector* F D, and the corresponding diameter D h, are equally inclined to the tangent D T [TANGENTS, METHOD OF], so that if the curve could reflect light, a ray issuing from the focus would be reflected parallel to the axis. Advantage is taken of this property in the construction of parabolic reflectors. [PARABOLOID OF REVOLUTION.]

Since the spaces described by falling bodies are proportional to the squares of the times, the equation $y^2 = px$ at once shows that the trajectory of every projectile in an unresisting medium must be a parabola whose diameter is parallel to the direction of the force of gravity. [GUNNERY; PROJECTILE.]

The parabola is also remarkable as being the first curve whose indefinite quadrature was effected. Archimedes found that the area enclosed between any parabolic arc, the diameter through one of its extremities, and the ordinate to that diameter through the other extremity of the arc, is equal to two-thirds of the parallelogram constructed on the ordinate and abscissa.

The term *parabola* is also applied to all algebraic curves of a higher order determined by an equation of the form $y^{m+n} = a^m x^n$. The curve whose equation is $y^3 = a^2 x$ is called the cubical parabola; and that which has for its equation $y^2 = a\,x^3$, the semicubical parabola. This latter curve is celebrated in the history of the algebraic analysis as being the first curve that was rectified, or found equal in length to an assignable straight line; and the honour of the discovery belongs to an Englishman, William Neil, who died in 1670 at the early age of thirty-three. The same discovery was made nearly at the same time by Van Heuraet in Holland: till then it had been supposed by geometers impossible to assign a straight line equal to the arc of any algebraic curve (the rectification of the cycloid had been found by Sir Christopher Wren); but the discovery of the method of fluxions soon showed that there are innumerable classes of curves susceptible of indefinite rectification. In fact, all parabolas of this form $y^{2n+1} = a\,x^{2n}$, where n is any number whatever, may be rectified. (Montucla, *Histoire des Mathématiques*, tom. ii. p. 151.) [CONIC SECTIONS.]

Parabola, Cubical. [CUBICAL PARABOLA.]

Parabola, Semi-cubical. A curve of the third order and class, having the equation $y^2 = a\,x^3$. It has a cusp at the origin and a point of inflexion at infinity. It is sometimes called *Neil's parabola.* [PARABOLA.]

Parabolic Curve. A curve of which the equation is of the form

$$y = a + bx + cx^2 + dx^3 + \&c.$$

Curves of this kind are frequently employed for the purpose of representing a number of observations, or for approximating to the areas of other curves: for it is always possible to cause a parabolic curve to pass through any number of points in a given curve, by making as many of the coefficients, a, b, c, &c., indeterminate as there are points given: and the curve thus described will differ less from the given curve according as the number of points is greater. But the area of the parabolic curve can always be determined; therefore that of the other curve may be found to any required degree of approximation.

Parabolic Cylinder. A surface generated by a line which moves parallel to itself and has a parabola for its directrix. Its plane sections are parabolas.

Parabolic Point. A point on a surface at which the indicatrix is a parabola. It is a cusp on the section of the surface made by the tangent plane. The inflexional tangents at the point coincide with the tangent at this cusp. [INDICATRIX.] The polar quadric at a parabolic point is a cone, and all such points lie upon the Hessian, which latter surface is of the order $4(n-2)$ when that of the original surface is n. The parabolic points, therefore, lie on a non-plane curve of the $4n(n-2)^{th}$ order. The tangent plane at a parabolic point is of the kind called *stationary* [STATIONARY TANGENT PLANES], and through any point in space pass, in general, $4n(n-1)(n-2)$ such planes.

Parabolic Spindle. The solid generated by the rotation around its chord of the segment of a parabola cut off by any line perpendicular to the diameter.

Parabolic Spiral. In Geometry, the name usually given to a curve derived from a common parabola by supposing its principal diameter to be wrapped round the circumference of a circle, the ordinates still remaining normal to the bent diameter, and therefore coinciding in direction with the radii of the circle. Calling a the radius of the circle, taking its centre as pole, and assuming as axis of polar coordinates the radius which passes through the vertex of the deformed parabola, the equation of the spiral will obviously be $(r-a)^2 = pa\theta$, where p is the parameter of the original parabola. Of the two branches of the curve, one will obviously remain without the circle, from whose circumference it will incessantly recede; the other will enter the circle, pass through its centre, when $\theta = \frac{a}{p}$, and finally leave the circle at the point diametrically opposite to that determined by

the value $\theta = \frac{4a}{p}$. The curve may be easily traced.

Paraboloid. A surface of the second order, some of whose plane sections are parabolas. Two kinds of paraboloids are distinguished, according to the nature of their non-parabolic sections. These will be found described under ELLIPTIC PARABOLOID and HYPERBOLIC PARABOLOID.

Paraboloid of Revolution. A surface of the second order generated by the rotation of a parabola around its principal or focal diameter. [ELLIPTIC PARABOLOID.] Its equation, referred to rectangular coordinate axes, whose origin is at the vertex, is $x^2+y^2=pz$, where p is the parameter, or double ordinate at the focus, of the generating parabola. The focus of this curve is also the focus of the surface. The instruments known in astronomy and physics as parabolic reflectors are of this form, since in virtue of a characteristic property of the parabola all rays issuing from the focus are reflected parallel to the axis. [PARABOLA.]

The solid bounded by a paraboloid of revolution and a plane perpendicular to its axis was formerly, and is still occasionally, called a *parabolic conoid.* Its volume is equal to one half the circumscribed cylinder, and to three halves of the cone having the same base and altitude.

Paracelsists. Followers of the school of Paracelsus in medicine, physics, and mystical science. The founder of this school may perhaps be called with justice the most distinguished quack who ever made a figure in the world. He practised medicine 'with the boldness of a wandering empiric,' and established a successful opposition to the traditionary doctrines of the so-called schools of Hippocrates and Aristotle. He mingled his medical and chemical knowledge with the speculations of the Cabbala, and with a theosophy of his own. He died in 1541. His followers continued to influence the schools of Germany for more than a century. (Hallam's *Introd. to the Literature of the Middle Ages*, i. 541, 639, ii. 70, &c.; Mosheim, vol. iv.)

Paracentesis (Gr. παρακέντησις, *perforation*). The operation of *tapping* any of the cavities of the body for the purpose of withdrawing a contained fluid.

Paracentric (Gr. παρά, and κέντρον, *centre*). In the higher Geometry, the name given to a curve line having this property, that a heavy body descending along it by the force of gravity will approach to or recede from a *centre* or fixed point, by equal distances in equal times.

Paracentric Motion. In Astronomy, the rate at which a planet approaches nearer to or recedes farther from the sun or centre of attraction in a given interval.

Paracephalophores (Gr. παρά; κεφαλή, *head*; and φέρω, *I carry*). A name given by M. de Blainville to a class of Molluscs, comprehending those in which the head is but little distinct from the body, but always provided with some of the organs of sense.

Parachute (Fr.). An apparatus resembling the common umbrella, but of greater extent, intended to enable an aëronaut, in case of alarm, to drop from his balloon to the ground without sustaining injury. This is effected by means of the resistance of the atmosphere. When the parachute is detached from the balloon, and abandoned with its load in the air, it must proceed at first, from the continued action of gravity, with an accelerated motion, until the increased velocity produces a resistance equal to the force of attraction, or the weight of the apparatus with its load. After this equilibrium has been attained, the parachute will descend with a nearly uniform velocity. According to theory, this terminal velocity, supposing the surface of the parachute to be flat, is equal to that which a heavy body would acquire in falling through the altitude of a column of air incumbent on that surface, and having the same weight as the whole apparatus. A circular parachute having a diameter of 30 feet, and weighing with its load 225 pounds, would acquire a terminal velocity of about 13 feet per second; and a person descending with it at this rate would receive the same shock on reaching the ground as if he dropped freely from a height of 2⅗ feet. (For the method of solving this problem, see Hutton's *Mathematical Tracts*, vol. iii. p. 316.) The actual resistance of the air is, however, greater than is given by theory, and is besides augmented by the concavity of the parachute, which occasions an accumulation of the fluid; but, on account of the action of the wind, the axis of the parachute will probably become inclined to the vertical, in which case the resistance will suffer a diminution.

One of the most remarkable instances of descent from a great height with a parachute is that of Garnerin, a Frenchman, who ascended in a balloon from an enclosure near North Audley Street, in London, on the 2nd of September, 1802. After hovering seven or eight minutes in the atmosphere, he cut the cord by which his parachute was attached to the balloon. It instantly expanded, and for some seconds descended with an accelerating velocity, till it became tossed extremely, and took such wide oscillations that the basket or car was at times thrown almost into a horizontal position. The intrepid aëronaut narrowly escaped destruction by being precipitated on the houses in St. Pancras, and at last fortunately came to the ground in a neighbouring field. He seemed to be much agitated, and trembled exceedingly at the moment he was released from the car. (*Ency. Brit.* 'Aëronautics.')

A more recent experiment with a parachute of somewhat different construction terminated fatally to Mr. Cocking, who conceived a notion that the vibrations might be avoided by giving the machine a different form. This projector constructed one in the form of an inverted umbrella, that is, having the concave side uppermost, and bound to a strong wooden hoop to

prevent its collapse in the descent. The diameter of the hoop was 34 feet; and there was also a hole of 6 feet in diameter in the middle of the parachute, which, it was supposed, would also contribute to give greater steadiness. Having attached himself to this machine, he ascended from Vauxhall Gardens on the 24th of July, 1837. On being cut away from the balloon, the parachute descended rapidly, and with violent oscillations: the hoop broke, and the unfortunate projector fell, dreadfully mangled, at Lee, near Blackheath.

Parachute Light. A suspended light for use in war, designed to illuminate a large extent of ground occupied by the enemy. It consists of a large calico parachute packed in an iron hemisphere, and attached by chains to a second hemisphere containing a light composition. The hemispheres are soldered together. The ball is fired at a high elevation from a mortar; at a given moment the fuse ignites a bursting charge, separates the hemispheres, and lights the composition. The parachute spreads out, and the light floats along, gradually descending, the flame issuing from a large vent at the bottom.

Paraclete (Gr. παράκλητος, *advocate*). A name applied to the Holy Spirit, as an advocate, intercessor, or comforter of mankind. It was a common opinion in the early centuries of the Christian era, that the Paraclete, whose mission was promised by Christ, was to appear corporeally upon the earth, and complete the dispensation. Thus Simon Magus, Manes, and others, pretended to be this expected Paraclete; and Tertullian himself was at one period infatuated by the claims thus advanced by Montanus.

Paracolumbite. A mineral found in black grains at Taunton in Massachusetts. It is said to contain iron and uranium, but no titanium.

Paracrostic. A poetical composition in which the first verse contains, in order, all the letters which commence the remaining verses of the poem or division. According to Cicero (*De Divinatione* ii. 54), the original Sibylline verses were paracrostics. [ACROSTIC.]

Paracyanogen. When cyanide of mercury is decomposed by heat, a brown solid matter remains having the same composition as gaseous cyanogen, and is hence called *paracyanogen*.

Parade (Fr.). The assembly of troops in regular order for inspection, muster, exercise, or any duty. Also the ground where troops are assembled.

Paradigm (Gr. παράδειγμα, *an example*). In Rhetoric, a general term used by Greek writers in the sense of *example* or *illustration*, of which *parable* and *fable* are species. (Quintilian v. 2.) Hence, in early theology, those writers who narrated the lives of religious persons, by way of examples of Christian holiness, were styled *paradigmatics*.

Paradise (Gr. παράδεισος, Arab. firdaus, Sansc. paradêsa). This name was used by the Greek historians to denote the extensive parks or pleasure grounds of the Persian monarchs. (Xenophon, *Cyrop.* and *Œconom.*; Diod. Sic. xvi. 41, xviii. 36; Aulus Gellius, ii. 20.) The Septuaginta have employed the word in their translation of Gen. ii. 8. It also occurs in other parts of their translation. (Numb. xxiv. 6; Gen. xiii. 10; Ezek. xxviii. 13, xxxi. 8.) It is used in the New Testament, in Luke xxiii. 43. The speculations to which this passage has given rise, form too extensive a subject to be entered upon here.

According to the rabbis, there is an upper or heavenly, and a lower or earthly, paradise. The lower is situated somewhere under the terrestrial equator. Each is divided into seven dwellings, and each of these is twelve times 10,000 miles in length and breadth. A column ascends from the lower to the upper heaven, by which the souls of the blessed mount after a temporary sojourn in the former. A wall of partition divides paradise from hell; and this will fall when the Redeemer comes, and all Israel be gathered together in blessedness.

The local situation of the terrestrial paradise has been a favourite subject of speculation, both with the fathers of the church and with later enquirers. The reader may consult the first volume of the compilation called the *Ancient Universal History*, where the matter is seriously discussed at great length; he will also find it treated in an entertaining article of the *Encyclopædia Metropolitana*. (See also Schulthess, *Das Paradies*, Zürich 1816.) The most ordinary opinion has placed it on the Euphrates and Tigris. Josephus regards the Pison mentioned in Genesis as the Ganges, the Gihon as the Nile. Hardouin places his in Palestine. Huet (*De la Situation du Paradis Terrestre*, 1691) enumerates a variety of these theories. The paradise of the Moslems is termed in the *Koran* Gannath, or the Happy Gardens; and its description is evidently borrowed from the notions of the rabbis and Oriental Christians. See, chiefly, chapters lv lvi.; but these passages, although flowery enough, contain a very small part of the extravagances, chiefly drawn from tradition, which make up the vulgar Mohammedan notion of paradise. (See, in addition to the authorities already cited, a learned article in the *Encyclopædia* of Ersch and Gruber.)

Paradise, Birds of. [PARADISEA.]

Paradisea. A genus of birds, much extolled in fiction, closely allied to the crows, but, unlike them, adorned with brilliant colours. The male especially is provided with very long hypochondrial feathers (the tufts of which are decomposed), as well as brilliantly tinted cervical plumes. These are erected on certain occasions, and form an exceedingly beautiful hoodlike crest. The fable invented by designing Chinese, that the Paradise birds had no feet, has been perpetuated by Linnæus, who termed the most common species *Paradisea apoda*.

Parados (Fr.). In Fortification, a traverse covering the interior of a work from reverse fire.

Paradox (Gr. παράδοξος, *contrary to received opinion*). A term applied to any proposition which seems to be absurd, or at variance with common sense, or to contradict some previously ascertained truth; though, when properly investigated, it may prove to be perfectly well founded.

Paradoxus. A name devised to express the obscure nature of a genus of Trilobites (fossil Crustaceans), to which it is attached, and which is characterised by the absence or indistinct nature of the prominent even-formed eyes which are borne on the shield of all other Trilobites. The segments extend beyond the sides of the body, and are free at their lateral extremity.

This word serves also as a specific name for obscure and anomalous animals, as *Ornithorhynchus paradoxus*, *Lepidosiren paradoxa*, &c.; or for plants which simulate other groups than that to which they belong, as *Stangeria paradoxa*, a cycad with leaves resembling ferns.

Paraffin. A name given by Reichenbach to a crystallisable hydrocarbon, contained in the products of the distillation of the tar of beech wood and of coral. The word is coined from the Latin parum, *little*, and affinis, *akin*, to denote the remarkable chemical indifference which is its characteristic feature. A similar substance has been obtained from the petroleum of Rangoon and from the products of the distillation of peat and lignite. At present it is manufactured in large quantities from some oily bituminous varieties of cannel coal. In these products it is accompanied by what is termed *paraffin oil*, which is chiefly a mixture of fluid hydrocarbons, some of which are largely used in lamps, and the less volatile of them for lubricating machinery. Pure paraffin resembles spermaceti in appearance; it is tasteless and inodorous; its specific gravity 0·870; it fuses at about 112°, and may be distilled unchanged at a higher heat. It is now largely employed in the manufacture of candles. [OILS.]

Paragium (Lat. par, *equal*). In Feudal Jurisprudence, the body of nobles (peerage) was so termed; the word likewise expressed equality of condition in various legal relations, as, for example, between the lords in partnership of a fief. Parage was also a custom by which the elder of several coheirs of a fief rendered homage for the whole, and thereby guaranteed the enjoyment of it to his coheirs as well as himself; in the same manner, one of several copurchasers might be admitted to a similar privilege.

Paragoge (Gr. παραγωγή). In Grammar, a figure by which one or more letters are added at the end of a word; e g. in the ordinary formation of diminutives in most languages. [METAPLASM.]

Paragogic Letters. In the Semitic languages, letters which, by their addition to the ordinary form of the word, import additional emphasis or some peculiar inflexion into the sense. Their real meaning and authority have been much debated among Hebrew scholars.

Paragon (Fr. parangon). A model, or pattern, implying special excellence or perfection.

PARAGON. In Printing, the name of a kind of type seven sizes larger than that used in this work. [TYPE.]

Paragraph (Gr. παραγραφή). This word ordinarily signifies a small subdivision of a connected discourse.

Paragraphê, as used by Greek rhetorical writers, is a poetical figure employed when the writer sums up in a few words the substance of a previous passage, by way of transition to a new one. (Eustathius *On Hom. Il.* i. 304.)

PARAGRAPH. In Printing, a sign ¶ used as a reference to notes in the margin or at the foot of the page. The paragraph mark is chiefly used in the Bible.

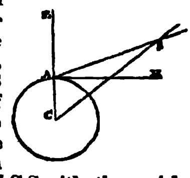
Paraleipsis (Gr. from παραλείπω, *I omit*). In Rhetoric, the artificially exhibited omission or slight mention of some important point, in order to impress the hearers with indignation, pity, &c., called by the Latins præteritio, omissio, &c.

Paralipomena (Gr. παραλειπόμενα, *things left out* or *aside*). A term applied, in Bibliography, to works of a supplementary character. The two books of the Old Testament called by us the Chronicles, are termed Paralipomena in the Septuagint, as supplementary to those of Kings.

Parallactic Instrument. An astronomical instrument for determining the moon's parallax, described by Ptolemy in his *Almagest*, and usually called *Ptolemy's Rule*. The term *parallactic* is sometimes applied to the equatorial; but in this sense the proper word would seem to be *parallatic*, as derived not from *parallax*, but from *parallel*, the instrument being constructed for the purpose of following the stars in their diurnal parallels. (Lalande, *Astronomie*, § 2278.)

Parallax (Gr. παράλλαξις, *a declension*). A change of place or of aspect. The term is used in astronomy to denote the difference between the *apparent* place of a celestial object and its *true* place, or that in which it would be seen if the observer were placed at the centre to which the motion is referred. When the point of reference is the centre of the earth, the change of aspect is called the *diurnal parallax*; when it is the centre of the earth's orbit, the change is called the *annual parallax*.

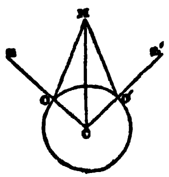
Diurnal Parallax.—Let C be the centre of the earth, A the place of the observer, Z his zenith, and S a celestial body. On observing the body from A, it will be seen in the direction A S, making the angle Z A S with the zenith. But if the observer could be placed at C, he would see the body in the direction C S, making the angle Z C S with the zenith. The difference between these two angles Z A S



and Z C S is the parallax of S, which, therefore, is equal to the angle A S C. Hence it appears that the parallax of a celestial body is the angle comprised between two lines drawn from the body, the one to the centre of the earth, and the other to a point on its surface. On account of the immense distance of the fixed stars, the diurnal parallax is altogether insensible with regard to them. It may amount to a degree in respect of the moon; but the greatest parallax of the nearest planet does not exceed 30″.

It is evident, from the inspection of the figure, that although the distance of the object S remain the same, the angle A S C is not a constant quantity, but is greatest when S is seen in the direction of the horizon A H, and diminishes as the altitude of S increases, until it vanishes altogether at the zenith, where the two lines A S and C S merge into the line C Z. In order to discover the law of this variation, let a = C A, the semidiameter of the earth; d = C S, the distance of the observed object from the centre; Z = Z A S, the apparent zenith distance; and P = A S C, the parallax. Now, the sides of a triangle being in the same proportion as the sines of their opposite angles, we have $d : a :: \sin Z : \sin P$, whence $\sin P = \frac{a}{d} \sin Z$. But as P is always a very small angle, the arc may be substituted for the sine without sensible error, and the formula becomes $P = \frac{a}{d} \sin Z$; that is to say, the parallax is proportional to the sine of the zenith distance. At the horizon Z is a right angle, and $\sin Z = 1$: in this case, therefore, the expression for the parallax becomes $P = \frac{a}{d}$. This is called the horizontal parallax; and when its amount has been determined by any means with respect to a celestial body, the parallax of the body at any altitude is found by multiplying the horizontal parallax by the cosine of the altitude, or sine of the zenith distance.

Since the parallax of a body is given in terms of its distance and the earth's semidiameter, it follows reciprocally that the distance of the body is given in terms of its parallax. The determination of the parallaxes of the different bodies of the solar system is therefore a problem of great importance in astronomy; but it is attended with considerable difficulty in practice, although the principle on which it depends is extremely simple. It may be described as follows: Let two observers be stationed at the points O and O′, of which the latitudes are supposed to be known, and which are both situated on the same meridian, and let them simultaneously observe the zenith distances of the body M (suppose the moon). These observations will give the angles Z O M and Z′ O′ M, and, consequently, M O C and M O′ C. The angle O C O′ is also known, being the difference or the sum of their latitudes, according as they are on the same or opposite sides of the equator. But the two sides C O and C O′ of the quadrilateral M O C O′, being radii of the earth, are also supposed to be known; hence the quadrilateral is determined, and its diagonal C M may easily be computed by the rules of plane trigonometry. But when C M is found, the horizontal parallax is also determined, being equal, by what has been already shown, to the quotient obtained by dividing the radius C O by the distance C M. In this manner the horizontal parallax of the moon was determined by Lacaille and Lalande; the former observing at the Cape of Good Hope, and the latter simultaneously at Berlin. There are methods, however, by which the lunar parallax may be determined by observations made at a single place.



The moon's mean horizontal parallax amounts to 57′ 4·17″, or ·95116 of a degree. In respect of all the other bodies of the solar system the parallax is an extremely small quantity, and, excepting perhaps in the case of Mars, cannot be determined by the method now described with sufficient precision and certainty That of the sun, the most important of all, is most accurately found by observations of the transits of Venus over his disc, as was first suggested by James Gregory, in his *Optica Promota*. It amounts only to 8·6″; whence it has been inferred that the mean distance of the sun from the earth is 23·984 times the length of the earth's radius, or about 95,000,000 miles. [SUN.] But considerable doubt has been thrown upon the correctness of this inference by recent astronomical and physical investigations, from which the mean distance of the earth from the sun appears to be only 93,000,000 miles. This determination suffices for finding the parallaxes and distances of all the planets in the system; for (in consequence of the relation established by Kepler's third law between the distances and periodic times) when the distance of any one planet from the sun is known, that of every other can be deduced from the times of revolution. [KEPLER'S LAWS.]

When the parallax of a celestial body has been determined, we can find not only the distance of the body, but also its diameter and real magnitude. For the apparent diameter being found by observation, the true magnitude is given by this proportion: The horizontal parallax is to the apparent radius, as the radius of the earth to the true radius of the body.

The effect of parallax is to depress the observed body in the vertical circle, or to increase its zenith distance. If the body at the time of the observation is on the meridian, the parallax only affects its declination; but if it is not on the meridian, the observed right ascension and declination are both altered, and the effect on each of these coordinates must be computed from the previously known horizontal parallax by the rules of spherical

trigonometry. The c   itation, in the case of the moon, is considerabl, complicated by the earth's ellipticity.

Annual Parallax.—In what has hitherto been said, the centre of the earth has been taken as the point of reference, and therefore regard has only been had to the difference of apparent situation occasioned by the eccentric position of the observer at the surface of the earth. But the sun, and not the earth, may be regarded as the centre to which the motion is referred; and the position of any celestial body, of which the distance from the sun is not so great as to be incomparable with the semidiameter of the earth's orbit, would be different if viewed from the sun from what it is when viewed from the earth. This difference is called the *annual parallax*. It is the angle under which the semidiameter of the earth's orbit would be seen from a superior planet, or from a fixed star. Such, however, is the enormous distance even of the nearest fixed stars, that very few of them have been found to be sensibly affected by annual parallax.

Mr. Henderson found a probable parallax of 1″ in the star α Centauri from observations made at the Cape of Good Hope. Sir William Herschel first pointed out the micrometrical measurements of the distances of two stars very close to each other, or nearly in the same line of vision, as a likely method of detecting parallax; for the apparent distance between two such stars, if either has a sensible parallax, must vary at different times of the year; and this method was applied by Struve, at Dorpat, to α Lyræ, and by Bessel, at Königsberg, to the double star 61 Cygni. The results obtained by the latter are the most unequivocal. By a series of observations with the heliometer, continued from August 1838 to March 1840, Bessel obtained the value of the parallax = 0·348″, a little more than the third of a second of space. Assuming this determination (and astronomers seem to regard it as established within certain small limits), the distance of the star from the earth must be 519,200 times the sun's distance—a distance so enormous that light, which travels at the rate of 190,000 miles in a second, would require 9½ years to pass through it. (*Monthly Notices of the Royal Astronomical Society* for May 1840. For the history of researches on the subject of the annual parallax, see *Mem. Royal Astronomical Society*, vol. xii.) [STAR.]

Parallel (Gr. παράλληλος, *side by side*). In Printing, a mark thus ‖, used as a reference to notes in the margin or at the bottom of the page.

Parallel Curves and Surfaces. Any curves or surfaces which have the same system of normals. Thus parallel plane curves have a common evolute of which they may all be regarded as involutes; and parallel surfaces have in common the same surface of centres of curvature. Corresponding points on parallel curves and surfaces are those which are situated on the same normal. Two parallel curves obviously intercept equal segments on all their common normals; in other words, the distance between two corresponding points is invariable, and the tangent planes at two such points are parallel. The pedals S_1 and Σ_1, with respect to any origin o, of two parallel surfaces S and Σ, manifestly intercept equal segments k on all radii vectores. But these pedals are inverse to the reciprocals S′ and Σ' of the parallel surfaces [PEDAL], so that if r' and ρ' are corresponding radii vectores of the inverse surfaces S′ and Σ', $r_1 = \frac{1}{r^1}$ and $\rho_1 = \frac{1}{\rho^1}$ will be those of the pedal surfaces S_1 and Σ_1, and from the relation $\rho_1 = r_1 + k$ we deduce $\frac{1}{r^1} = \frac{1}{\rho^1} + k$. From the polar equation of the reciprocal of S, therefore, we may at once obtain the polar equation of the reciprocal of its parallel Σ, and from the latter that of Σ itself. The parallel surface may be regarded as the locus of the centre of a sphere of constant radius k, which touches the primitive, so that if

$$F(\xi, \eta, \zeta) = o$$

be the equation of the given surface S, and

$$(\xi - x)^2 + (\eta - y)^2 + (\zeta - z)^2 - k^2 = o,$$

that of a sphere whose centre is at (x, y, z) and whose radius k is constant, the algebraical expression of the condition that these two surfaces shall touch each other will be the equation of the parallel surface. This method of obtaining the equation of the parallel surface has been proposed by Salmon, and applied by him to the parallel of the ellipsoid. Mr. W. Roberts has pointed out several interesting relations between parallel and pedal surfaces. (*Phil. Mag.* vol. xxiv. 1862.)

Parallel Lines. In Geometry, 'straight lines which are in the same plane, and which, being produced ever so far both ways, do not meet.' (Euclid, bk. i. def. 35.)

The subject of parallel lines is one of the most difficult in the elements of geometry, and has accordingly given rise to much learned discussion. The difficulty consists in demonstrating that two parallel lines, when they meet a third line, are equally inclined to it, or make the alternate angles with it equal. In order to demonstrate this proposition, Euclid assumes as an axiom that 'If a straight line meet two straight lines, so as to make the interior angles on the same side of it less than two right angles, these straight lines, being continually produced, will at length meet on the side on which the angles are which are less than two right angles.' But this is not a self-evident truth: it is, in fact, a proposition which requires to be demonstrated; and the converse of it, namely, that two straight lines which meet one another make with any third line the interior angles less than two right angles, forms the 17th proposition of Euclid's first book. Geometers have attempted in many different ways, but without complete success, to remove this blemish from the *Elements* The methods which they

have employed for this purpose are of three kinds: 1. By adopting a new definition of parallel lines; 2. By introducing a new axiom; 3. By reasoning merely from the definition of parallel lines and the properties of lines already demonstrated.

Some geometers, among whom are Wolfius, Boscovich, and Thomas Simpson, have adopted the following as the definition of parallel lines; namely, that 'straight lines are parallel which preserve always the same distance from each other;' but this, like Euclid's definition, as remarked by D'Alembert, is begging the question. The correct definition would be, that 'two straight lines are parallel when there are two points in the one from which the perpendiculars drawn to the other, and on the same side of it, are equal.' The difficulty then consists in demonstrating that *all* the perpendiculars drawn from the one of these lines to the other are equal. Another definition, which has been adopted by Varignon, Bezout, and others, is, that 'parallel lines are those which make equal angles with a third line towards the same parts, or make the exterior angle equal to the interior and opposite.' When this definition is adopted, the difficulty consists in proving that straight lines which are equally inclined to one *given* straight line must be equally inclined to *all* the other straight lines which fall upon them.

Of the new axioms which have been substituted in place of Euclid's, we shall merely notice that given by Thomas Simpson, in the second edition of the *Elements*; namely, that 'If two points in a straight line are posited at unequal distances from another straight line in the same plane, those two lines, being indefinitely produced on the side of the least distance, will meet one another.' By help of this axiom he proves that if two straight lines are parallel, the perpendiculars to the one terminated by the other are equal, and also perpendicular to the other parallel; and thence the proposition from which all the rest follows, namely, that if a straight line fall on two parallel lines, it makes the alternate angles equal. Playfair remarks on this method, that it is extremely plain and concise, and perhaps as good as any that can be followed when a new axiom is assumed.

Legendre, in his *Elements of Geometry*, has attempted to overcome the difficulty of parallel lines by previously demonstrating that all the angles of a triangle are equal to two right angles, from which proposition it is easy to prove everything with respect to parallels. His demonstration, however, is of too refined and subtle a kind to be admissible into the *Elements*. (See Notes to Playfair's *Euclid*, Legendre's *Geometry*, and Leslie's *Geometry*.) But the reader who wishes to have a complete view of what has been written on this subject, should consult a learned *excursus* to the first book of Camerer's *Euclid*, Berlin 1825; and also Colonel P. Thomson's *Geometry without Axioms*.

It may be remarked, that the whole of the difficulty which exists with respect to the doctrine of parallel lines is of a metaphysical rather than of a mathematical kind; and the learner need not perplex himself about subtleties which can hardly be considered as affecting the rigour of geometrical truth.

Parallel Motion. The parallelism of motion of the piston-rods of steam engines. The term was invented by James Watt in order to express the connection of the motion of the piston, which is vertical or horizontal, with that of the balance beam, which is partly circular. The principle of the mechanism consists in the fact that in every parallelogram, the three angles being attached and revolving in arcs of circles, the fourth will continue nearly in a straight line of movement.

Parallel Planes. Planes which never meet, though indefinitely produced

Parallel Ruler. A mathematical instrument for drawing parallel lines. There are two kinds of parallel rulers. The one consists of two equal flat rulers connected by two equal and parallel crossbars which turn round their extremities; the other is a simple flat ruler which runs on two wheels whose circumferences are equal. The latter is the more modern and convenient form.

Parallel Sailing. In Navigation, sailing on a parallel of latitude, or circle parallel to the equator. [NAVIGATION.]

Parallel Sphere. In Geography, that position of the sphere in which the equator coincides with the horizon, and the poles are in the zenith and nadir. This is the appearance which the sphere would have to a spectator placed at the pole. The stars neither rise nor set, but move constantly in circles parallel to the horizon; and the sun rises and sets only once a year.

Parallels. In the attack of a fortress, wide trenches parallel to the attacked work, protecting the besieging troops. The parallels are connected by approaches or zigzags.

Parallels of Altitude. In Geog small circles of the sphere parallel to horizon; also called ALMACANTARS.

Parallels of Declination. In Astronomy, small circles of the sphere parallel to the equator.

Parallels of Latitude. On the Terrestrial Sphere, small circles parallel to the equator; but, in the Celestial Sphere, they are parallel to the ecliptic.

Parallelogram (Gr παραλληλόγραμμος). A plane quadrilateral figure of which the opposite sides are parallel. Its characteristic properties are: 1. Its opposite sides are equal; 2. Its opposite angles are equal; 3. Its diagonals bisect one another as well as the figure itself. An equilateral and equiangular parallelogram is called a *square*; if merely equilateral, it receives the name of *rhombus* or *lozenge*; if merely equiangular, it is termed a *rectangle* or *oblong*.

Parallelopiped (Gr. παραλληλεπίπεδον, *parallel-plane solid*), written also

piped. The name given to a solid bounded by three pairs of parallel planes. It has eight solid angles, each formed by the meeting of three-plane angles; its six faces are all parallelograms, and its twelve edges consist of three sets of four equal and parallel lines. It may be regarded also as a quadrangular prism of which any face may be considered as the base, the distance between that face and the opposite one being then the *altitude*. The volume of any parallelopiped, therefore, is expressed by the product of the area of any face into the perpendicular distance between that face and the opposite one. [PRISM.] Its four diagonals meet in a point, and bisect one another; the sum of their squares being equal to the sum of the squares on the twelve edges or sides. In the case of a *right* or *rectangular* parallelopiped, all of whose plane angles are right angles, the four diagonals are equal, and the square on any one is equal to the sum of the squares on the three lines which then correspond to the *length*, *breadth*, and *height* of the solid. When the latter are all equal, the parallelopiped takes the more convenient name of cube.

Paralogism (Gr. παραλογισμός, from παρά, *beside*, and λόγος, *reason*). In Logic and Rhetoric, a reasoning which is false in point of form; i.e. in which a conclusion is drawn from premisses which do not logically warrant it. It is the opposite to a syllogism, or correct logical deduction. [SYLLOGISM.]

Paralogite. A silicate of alumina, lime, and soda, found in Lapis Lazuli, in the neighbourhood of Lake Baikal in Siberia. It is probably a variety of Scapolite.

Paralysis (Gr. παράλυσις). Palsy. A diminution or loss of power of any part of the body. In general one side only is affected, constituting the condition known as *hemiplegia*; or the upper or lower extremities become paralysed, when *paraplegia* is the result. Whatever debilitates the system may produce palsy; it is also produced by pressure upon certain parts of the brain and spinal marrow, and occasionally by poisons, by local injuries, and by the sudden suppression of certain evacuations. It frequently produces a distortion of the mouth or eye, the speech becoming indistinct, and the judgment often impaired. The treatment of palsy depends upon a careful consideration of its cause; depletion is seldom required. Purges and nervine stimulants, such as ammonia, &c., are often useful, and blisters to the head and neck. Many cases, however, may be seriously injured by the incautious use of depletory and depressing measures.

Parameter (Gr. παραμετρέω, *I measure by another thing*). In Mathematics, a term applied to some characteristic magnitude whose value, invariable as long as one and the same function, curve, surface, &c. is considered, serves to distinguish that function, curve, surface, &c. from others of the same kind or family. [ELLIPTIC INTEGRAL; ENVELOPES; CONIC SECTIONS; &c.]

Parameters, Variation of. A method invented by Lagrange, and often employed with advantage in the solution of differential equations. It may be roughly described as a method of modifying the known solution of one differential equation so as to make it satisfy another of more general, but allied form; such modification being affected by supposing the arbitrary *constants* of integration to become functions of the variables.

Paramo. The name given in South America to a mountainous district covered with stunted trees, exposed to the winds, and in which a damp cold perpetually prevails. Under the torrid zone, the Paramos are generally from 10,000 to 12,000 feet in height. Snow often falls on them, but remains only a few hours; in which respect they are distinguished from the *Nevados*, which enter the limits of perpetual snow. The Paramos are almost constantly enveloped in a cold thick fog; so that when a thick small rain falls, accompanied with a depression of the temperature, they say at Bogotá or at Mexico, *cae un paramito*. Hence has been formed the provincial word *emparamarse*, to be as cold as if one were on a *paramo*.

Paramoudra. A peculiar variety of flint, common in the chalk near Norwich and elsewhere, and consisting of pierced cylindrical columns, generally almost vertical or at right angles to the bedding of the chalk in which they are found. As all the flints in chalk seem to have been originally organic, the existence of these large and singularly shaped masses is not easily explained. They are almost always in groups, two or three or more, one above another, with a pipe of communication running through all of them.

Paramount. In Feudal Law, the superior lord, as opposed to *paravail*, the inferior who *holds* of him: from the old French phrase, par à-mont and par à-val, *upper and lower*.

Paranaphthalin. A white solid substance, so termed because it resembles and accompanies *naphthalin*. It has also been called *anthracene*. It is represented by the formula $C_{28}\ H_{10}$.

Paranthine. A name for certain compact varieties and crystals of white and pale blue Scapolite; found in the limestone quarries at Malsjö, in Sweden.

Paranymph (Gr. παράνυμφος). A bridesman.

Parapet or **Breastwork** (Ital. parapetto). In Fortification, a bank, generally of earth, for the purpose of protecting troops from an enemy's fire. It should be sufficiently high, both in field and permanent works, to cover the troops behind it, and is therefore usually made about eight feet high; and it must be so thick that no shot can pass through it. Parapets of brick or stone, though requiring less thickness, are objectionable on account of the splinters caused by shot striking them, and parapets of iron should therefore be constructed in restricted sites, where earth would occupy too much space.

Paraph (Gr. παρά, and ἅπτω, *I fix*). In Diplomatics, the figure formed by a flourish of the pen at the conclusion of a signature. This formed, in the middle ages, a sort of rude provision against forgery, like the flourishes in the plates of bank notes. In some countries (as in Spain) the paraph is still a usual addition to a signature.

Paraphernalia (Gr. παράφερνα, from παρά, and φερνή, *a dowry*). In Law, the apparel, jewels, &c. of a wife, which are held to belong to her as a species of separate property. The husband may dispose of them in her lifetime, but cannot bequeath them away from her; and if he have not parted with them before his death, she may retain them against his executors and all other persons, except his creditors, where his other funds are not sufficient to satisfy their claims. But she cannot dispose of them during her husband's lifetime. Gifts of jewels &c. made to the wife by a relative or friend either upon or after her marriage will generally be considered in Equity as made for her *separate use*, in which case they will not be reckoned amongst her paraphernalia, but may be disposed of by her as if unmarried.

Paraphonia (Gr.). Alteration of voice.

Paraphrase (Gr. παράφρασις). In Rhetoric, the rendering of a passage or portion of writing in other phraseology, more distinct and easier of explanation, and therefore usually at greater length. A loose translation, or one in which a new series of ideas and illustrations conveying the same general meaning with those of the original is substituted for them, is also termed a paraphrase, although not with strict propriety.

Paraphyses (Gr. παρά, and φύσις, *nature*). A term used in describing Mosses, to denote the sessile ovate abortive bodies placed below the theca.

Paraplegia (Gr. παραπληξία). Palsy of the upper or of the lower half of the body.

Parapophysis (Gr. παρά; ἀπόφυσις, *a process*). In Anatomy, the process which extends outwards, or outwards and downwards, from the body of the vertebra in fishes, and from the same part in the cervical and anterior dorsal vertebræ of the crocodile, where it has been called the *inferior transverse process*. It is sometimes ossified from an independent centre, or confluent with the upper transverse process, or diapophysis.

Parasang (Gr. παρασάγγης, Pers. farsang). A Persian measure of length; according to Herodotus, equal to thirty stadia, and (reckoning eight stadia to the English mile) equal to 3¾ English miles. The length of the parasang was reckoned differently by different authors; and some have assigned to it the length of sixty stadia.

Parascenium (Gr. παρασκήνια). In the Greek theatre, probably the space on each side of the stage, to which actors withdrew on quitting the stage. [POSTSCENIUM.]

Paraselenæ. [PARHELION.]

Parasite (Gr. παράσιτος, from παρά, and σῖτος, *food*). Originally, according to Crates in Athenæus, a term of honour, being the appellation of certain ministers at sacrifices, whose office is not distinctly ascertained. (*Mém. de l'Acad. des Inscr.* vol. xxxi.) The habits of a luxurious age produced the race of poor companions, ready guests at the table of a patron, who formed a standing character in the later Greek comedy. Some attribute the first conception of the dramatic personage to Araros, the son of Aristophanes. Diphilus, according to Athenæus, gives the most complete portrait of it in his comedy *Telesias*. Our notions of the ancient parasite are now derived chiefly from the Latin comic poets. Ingenious writers have divided parasites into four classes: 1. The poor confidential friend, whose services to his patron are sometimes rendered with a mixture of real attachment, as in the character of Ergasilus in the *Captives* of Plautus. 2. The guest who is invited with a view to make him pay for his reception by the exertion of his powers of entertainment (Anglicè, diner-out), the *ridiculi* and *derisores* of Plautus, and who alone are described under the name of parasites by Julius Pollux; Vibidius and Balatro, the two umbræ of Mæcenas at the supper of Nasidienus (Hor. *Sat.* ii. 8), seem to have partaken of this quality. These degenerated, thirdly, into the class of mere buffoons, who were invited to play tricks and undergo practical jokes, under pain (as Ergasilus complains in the play already cited), if they refused to lend themselves to the manual pleasantries of the guests, of 'taking up their beggar's wallet and marching.' The fourth and worst class, κόλακες, were the attendant flatterers of their patron. Such is Artotrogus, or Loaf-eater, the humble companion of Pyrgo-Polinices in the *Miles Gloriosus* of Plautus; and the best known of all parasites, Gnatho, in the *Eunuch* of Terence.

Parasites. In Zoology, this term, as designative of a group of animals, is variously applied by different naturalists. Lamarck includes under it a family of antennated Arachnidans; Cuvier, Latreille, and Kirby apply the term to an order of Apterous insects; Strauss to a tribe of Crustaceans: but all the sections include animals of parasitic habits. They have been divided into *external* and *internal* parasites; the latter being more definitely termed ENTOZOA.

Parasitical Plants. Those which grow into the tissue of other species, and feed upon their juices. Of this kind are the Mistleto (*Viscum*), the Broom Rape (*Orobanche*), the *Lathræa*, and many *Fungi*; and, among exotics, the monstrous *Rafflesia*. Such species have no proper roots. The term *parasitical* is, however, often applied improperly to Mosses, Orchidaceous plants, *Tillandsias*, and the like, which are mostly Epiphytes, growing upon the bark of trees, but deriving their food from the air by means of their own roots.

Parastatæ (Gr. παραστάτης, *one who stands near another*). In Architecture, pilasters, or rather square pillars, which stand insulated from the walls. [ANTÆ.]

Parastilbite (Gr. παρά, and Stilbite). A zeolitic mineral from Thyrill in Iceland.

(Gr.). In Grammar, opposed to Syntax. The mere ranging of propositions one after another, as the corresponding judgments present themselves to our mind, without marking their dependence on each other by way of consequence or the like.

Paravail. [PARAMOUNT.]

Parbuckle. A Naval term for the operation of raising or lowering a cask, gun, or other cylindrical body by means of one rope, and applicable either to an inclined plane or to a vertical stage. In the process a bight at the middle of the rope is passed round a post or some fixed object at the top of the stage. The two ends of rope are then passed under the cylindrical body near its respective ends, and thence into the hands of two men, who hoist or lower equally. Each man has thus to sustain one-fourth of the weight of the body.

Parbuckling. In Artillery, rolling a gun by means of ropes made fast at one end, and then passed round the gun, when their running ends are hauled on. The gun itself acts as a movable pulley.

Parcæ. The Latin name of the Fates. According to Klausen, the original Roman Parca was equivalent to Mors, the goddess of death. It was not until the Augustan age, that the Parcæ became plural (Virg. *Ec.* iv. 47), and acquired their similarity to the Greek Moirai, Clotho, Lachesis, and Atropos. [FATES; MOIRA.]

Parceners. In Law. [COPARCENERS.]

Parchment (Fr. parchemin). A material for writing formed of the prepared skins chiefly of sheep and goats. A similar preparation of calves', kids', and lambs' skins is called *vellum*. The skins are first prepared as for tanning; then shaved down and pumiced; and lastly, stretched and carefully dried. The parchment of drums is made of the skins of asses, calves, and wolves; ass skin is used for battledores; and goat skin is preferred for sieves. For some kinds of bookbinding, parchment and vellum are dyed of various colours.

Parchment was known at a very early period. It was used for writing as early as the year 250 before the Christian era by Eumenes, king of Pergamus, who, desirous of collecting a library which should vie with that of Alexandria, but prevented by the jealousy of the Ptolemies from obtaining a sufficient quantity of papyrus, had recourse to this substitute; and its invention at Pergamus claimed and secured to it the lasting name of Pergamena; whence *parchment*. (Sir G. Wilkinson's *Manners and Customs of the Ancient Egyptians*, iii. 151.) In the beginning of the eighth century, the use of the papyrus was almost entirely superseded by parchment, on which we find that all the public documents under Charlemagne and his dynasty were written. When the different kinds of parchment came into use for the purposes of writing, they were rolled up before they could be sealed; hence the word *volumen*, from Lat. volvere, *to roll*. And as the scribes wrote to the very bottom of the parchment, i. e. to the place where the cord used for the folding was fastened, we may account for the well-known expression *opus ad umbilicum perductum*.

Parchment is used in Printing for covering the tympans of the press, both inner and outer, which should be of a uniform thickness.

Parchment Paper, Vegetable Parchment. This curious modification of vegetable fibre is made by steeping unsized paper in a mixture of oil of vitriol with half its bulk of water, at the temperature of 60°, quickly withdrawing it, washing it well with water, then with a very weak solution of ammonia, then with water again, and finally carefully drying it. In this process the fibre is mechanically rather than chemically changed; the pores are filled up; it is tough, translucent, and nearly impermeable to water. It takes ink well, and is put to many important uses. It is a good substitute for bladder in electrolytic operations, and for tying over pickles and preserves: it long resists the action of water, which even when boiling has little effect upon it for some hours. By protracted immersion it slowly loses its tenacity.

Pardon. In Law. It is a part of the prerogative of the crown to pardon all offences merely against the crown or the public, excepting the offence of committing any person to prison out of the realm, which, by the Habeas Corpus Act, is made a præmunire, unpardonable even by the king, and excepting those offences in the prosecution of which private justice is principally concerned, as nuisances, while unredressed, and so as to prevent their abatement. Thus pardon cannot be pleaded to a parliamentary impeachment so as to impede the enquiry. But, even in the above cases, the fine or punishment may be remitted. Pardon is granted under the great seal, or by warrant under the sign manual, countersigned by one of the principal secretaries of state, or by Act of Parliament. Its effect is in almost all cases to make the offender a new man, and to discharge him from all the penal consequences attaching to his offence. By 9 Geo. IV. c. 32 punishment has the same legal effect as pardon.

Parecbasis (Gr.). In Rhetoric, the word used by Greek authors to signify what by the Latins is called digression; by Quintilian (iv. 14) termed 'alienæ rei, sed ad utilitatem causæ pertinentis, extrà ordinem occurrens tractatio.'

Paregoric (Gr. παρηγορικός, *soothing*). That which allays pain. *Paregoric elixir* is a camphorated tincture of opium flavoured by oil of aniseed.

Pareira Brava. The root of the *Cissampelos Pareira*, brought from South America. It has a sweetish and a bitter flavour, and has been used in nephritic complaints and some affections of the bladder.

Parella. In Botany, a kind of lichen, the *Lecanora parella*, found on rocks in mountainous countries, especially in the north of Europe.

It is the *Perelle* of Auvergne, where it is extensively used by the dyer, and is found equal to orchil (*Roccella tinctoria*).

Parembolê (Gr. from παρά, and ἐμβάλλω, *I throw in*). In Rhetoric, a figure by which a paragraph is inserted in the middle of a sentence with which it does not grammatically cohere, by way of explaining something. It is also called *paremptosis*, and is a species of parenthesis.

Parenchyma (Gr. παρέγχυμα). The spongy and cellular tissue of animals and vegetables. The old physiologists supposed that the crude juices underwent a kind of filtration in the cellular substance.

Parenchymatous Entozoa, Parenchymatosa. An order of Entozoa, including those which have their nutrient canals simply excavated in the parenchymatous tissue of which their entire body is composed. [STERELMINTHA.]

Parenthesis (Gr. *an insertion*). In Printing, the mark ( ) enclosing some necessary information or useful remark introduced into the body of the sentence, but which may be omitted without injury; as,

> Know then this truth (enough for man to know),
> Virtue alone is happiness below.

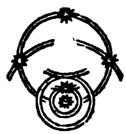
PARENTHESIS. In Rhetoric, a figure by which a series of words is inserted in a sentence, having no grammatical connection with those which precede or follow, with the object of explaining some detached portion of the sentence.

In ancient authors, a parenthetical form of writing is even more common than among moderns; because much which a Greek or Roman author would have conveyed by way of parenthesis is now inserted in separate explanatory notes.

Pargasite. Hornblende of high lustre and of a rather dark green colour, containing alumina, iron, and magnesia; found at Pargas in Finland.

Parget (Lat. parietare, from paries, *a wall*). In Architecture, the plaster formed of lime, hair, and cowdung, used for coating the flue of a chimney.

Parhelion or **Mock Sun** (Gr. παρήλιος, *near the sun*). A meteor which consists in the simultaneous appearance of several suns, 'fantastic images of the true one.' These images appear at the same height above the horizon as the true sun, and they are always connected with one another by a white horizontal circle or halo, of which the pole is at the zenith, and the apparent semidiameter equal to the sun's distance from the zenith. The images or mock suns, which appear on the same side of this circle with the true sun, are tinted with the prismatic colours; and sometimes a part of the circle itself contiguous to them appears coloured. But those which appear on the circumference opposite to the sun are always without colour; whence it may be conjectured that these (as well as the luminous ring itself) are produced by reflection, and the others by refraction. In general, when these phenomena are produced, the sun is surrounded by one or more concentric circular coronæ which exhibit the colours of the rainbow; and sometimes arcs of circles, or even entire circles, appear touching the coronæ. These also are coloured, and contain other parhelia. The phenomenon has been described by Aristotle, Pliny, Scheiner, Descartes, and many others; but the most perfect apparition yet recorded is that which was observed by Hevelius at Dantzic, on the 20th of February, 1661. It is represented in the annexed figure.



Parhelia have continued visible for two, three, or four hours. In general two, but sometimes four, and even six or seven, are visible together.

No very satisfactory explanation of the cause of these curious but rare phenomena has yet been given. Huygens supposed them to be produced partly by the reflection and partly by the refraction of the sun's rays, falling on an infinite number of small cylinders of ice suspended vertically in the atmosphere, and having certain determinate positions relative to the sun and the observer. This theory is explained at length in the second volume of his *Opera Posthuma*. (Smith's *Optics*; Priestley *On Light*; Biot, *Traité de Physique*, tom. iii.)

Fraunhofer, in a memoir on halos and parhelia published in Schumacher's *Astronomische Abhandlungen*, p. iii., has attempted to explain these phenomena on a different principle. On looking at the sun through a horizontal grating of very fine wires, two images of the sun appear, one above and the other below the true sun; and, if there is some inequality in the distances between the wires, the images appear slightly coloured, and a vertical streak of light is seen. Fraunhofer thinks that this affords a clue to the theory of the parhelia; for if the small spherules of moisture floating in the atmosphere are disposed in horizontal parallel lines with tolerable regularity, two vertical parhelia (but this is a very rare phenomenon) will be seen; and if they are disposed in vertical lines, the more common phenomena of horizontal parhelia with the luminous circles may be produced. It must be confessed, however, that even when this arrangement of the particles of vapour in parallel lines is admitted, several circumstances attending the phenomena will still remain unexplained.

Paraselenæ, or images of the moon, are also seen under similar circumstances as parhelia: the same theory will of course apply to both.

Parian Chronicle (so called from the island of Paros, where it was originally found). The name given to one of the celebrated marbles imported into England with the rest of the collection known as the Arundelian. In its perfect state it contained a chronological register of the principal events in the mythology and history of ancient Greece during a series of 1318 years, beginning with the reign of Cecrops, the first king of Athens, and ending with the archonship of Diognetus; but the last

ninety years are nearly obliterated by the injuries of time, so that the part which now remains ends at the archonship of Diotimus, B.C. 354.

The marble on which the chronicle is engraved is 5 inches in thickness, and measured, when Selden viewed it, 3 feet 7 inches by 2 feet 7; but one corner had been broken off. It contained originally about 100 lines, each consisting on an average of 16 words, or 130 letters; so that the whole might have been comprised in six octavo pages.

This venerable monument was purchased at Smyrna, with many others, by Mr. W. Petty, who was employed by the earl of Arundel, in the year 1624, for the purpose of collecting marbles, books, statues, and other curiosities in Italy, Greece, and Asia Minor. When brought to England, in 1627, it was placed in the gardens belonging to Arundel House, the site of which is now occupied by Arundel, Norfolk, Surrey, and Howard Streets, in the Strand. It was examined by some of the most distinguished literati of that time; among whom were Sir R. Cotton, Selden, Patrick Young, and Richard James. After much labour it was deciphered, and a copy of it published by Selden in the year 1628, accompanied with a Latin translation and commentary.

During the civil wars, and the time of the Commonwealth, the Parian Chronicle was unfortunately broken into smaller fragments, and almost entirely defaced. The upper part, containing nearly half the original tablet, is said to have been used in repairing a chimneypiece or hearth in Arundel House; but luckily the inscription, or at least as much of it as could be made out, was preserved in the copy which Selden had previously taken and published. In the year 1667 the remaining fragments were presented by the Hon. Henry Howard, grandson of the first collector, to the university of Oxford, where they are now deposited.

The genuineness of this relic was acknowledged throughout Europe as soon as its contents were made known. Its authority was considered as equal, if not superior, to any other; nor was its authenticity impeached till the year 1788, when the Rev. John Robertson published a volume called *A Dissertation on the Authenticity of the Parian Chronicle*, in which he maintained it to be a fabrication of modern times. The doubts and objections of Mr. Robertson were founded on the following considerations:—

1. The characters have no certain or unequivocal marks of antiquity. 2. It is not probable that the chronicle was engraved for private use. 3. It does not appear to have been engraved by public authority. 4. The Greek and Roman writers, for a long time after the date of this work, complain that they had no chronological account of the affairs of ancient Greece. 5. This chronicle is not once mentioned by any writer of antiquity. 6. Some of the facts seem to have been taken from authors of a later date. 7. Parachronisms appear in some of the epochs, which we can scarcely suppose a Greek chronologer, in the 129th Olympiad, would be likely to commit. 8. The history of the discovery of the marbles is obscure and unsatisfactory; and 9. The literary world has been frequently imposed upon by spurious books and inscriptions, and therefore we should be extremely cautious with regard to what we receive under the name of antiquity.

These observations were made the subject of separate chapters and disquisitions, and were illustrated with such candour and learning that for a short time the credit of the Parian Chronicle was shaken in the public opinion. Early, however, in the following year, the objections of Mr. Robertson were replied to by Mr. Hewlett, in a pamphlet entitled *A Vindication of the Authenticity of the Parian Chronicle*, London 1789; by Mr. Gough in the ninth volume of the *Archæologia*; and by Porson, in the *Monthly Review*; and the result of their enquiries, coupled with the defence of Wagner (Gött. 1790), and the more recent investigations of Hales in his *Chronology*, and of Boeckh in the second volume of his *Corpus Inscriptionum*, leave no doubt respecting the authenticity of the Chronicle, in which, however, legend and history are blended together without any consciousness of transition in the mind of the inscriber. (Grote's *History of Greece*, vol. ii. p. 58.) [HISTORICAL CREDIBILITY.]

Parian Marble. [MARBLE.]

Parias. The lowest class of the inhabitants of some parts of Hindustan, who have, properly speaking, no caste, and are supposed to be descended from original races of occupiers long since conquered by foreign invaders. In the widest sense, the term appears to comprehend *all* the different classes of distinct non-Hindu tribes, and degraded or foreign races, not comprised in the four Hindu castes; forming, probably, nine-tenths of the whole population, exclusively of the Mussulmans.

Parietal (Lat. paries, *a wall*). In Botany, any organ which grows from the sides of another. Those ovaries are parietal which grow from the sides of a calyx; and placentæ or ovules have this name when they proceed from the sides of the ovary.

Parietal Bones. In Anthropotomy, two arched and irregularly square bones, one on each side of the superior part of the skull. So called from the Latin paries, *a wall*, because they protect the brain like walls. In homological anatomy, they are the neural spines of the parietal segment of the skull.

Pariglin or **Parillin.** The supposed active principle of sarsaparilla. It has also been called *smilacine*. It appears to be the parillic acid of Batke. It is a white crystallisable substance, inodorous, and nearly tasteless. Little is known of its medical virtues. It is said to be identical with *saponin*.

Parinarium (from Parinari, its Guiana

name). A genus of *Chrysobalanaceæ*, consisting of large trees, many of them yielding plum-like fruits. That of *P. excelsum*, called Grey Plum, is brought into the markets of the west coast of Africa, but is not much esteemed. That of *P. macrophyllum*, also West African, is called Plum. The leaves of *P. laurinum* supply the chief material used by the Polynesians for covering the side walls of their houses, while its seeds yield them a perfume.

Paring and Burning. The operation of paring off the surface of worn-out grass land, or lands covered with coarse herbage, and it for the sake of the ashes, and for the destruction of weeds, seeds, insects, &c. Agriculturists differ as to the value of this mode of improving land; the greater number preferring a naked fallow even for one or two years, alleging that more injury is done by the loss of vegetable matter in burning than is compensated by the ashes produced. Where the object is to bring land abounding in coarse herbage immediately into a state of good culture, paring and burning is evidently the most rapid mode that can be employed; and if the soil contains calcareous matter, burning will have nearly the same effect on it as if a dressing of quicklime had been applied. Much, however, depends on the mode in which the land is treated afterwards. Stifle burning, in which stubble or weeds are used as fuel, to heat heaps of clods and earth gathered from the cultivated surface, is found a most fertilising process, on calcareous soils. Ordinary burn- in a more complete incineration of the portion of soil (perhaps 100 cubic yards per acre) submitted to it, is also found to be a most beneficial tillage operation on all calcareous clays.

(Gr.). In the Homeric Mythology, the seducer of Helen, and the cause of the Trojan war.

The myth of Paris may be fairly regarded as the most important in the whole range of Greek legends, because from it have grown, or round it have clustered, most of the tales which make up the great epic cycle. But this myth cannot be gathered from any one source. Part of it is related in the *Iliad*, part of it is given by the poets of a later age, and part of it we receive from mythographers, like Apollodorus and the Homeric scholiasts. In the articles Epic Poetry, Homeric Poems, and Iliad, some reasons have been given for thinking that the silence of Homer (if we may use the name without admitting the personality of one poet for the *Iliad* and *Odyssey*) is not conclusive evidence of the later origin of legends or portions of legends not noticed by him. The idea that the *Iliad* tells the tale of the Trojan war is a popular delusion. It professes to speak only of the wrath of Achilleus, and the whole poem does not speak even of this. In short, it narrates only the events of a few months, and therefore it follows necessarily that the poet has made use of those incidents only which suited or were needed for his immediate purpose. But casual expressions furnish conclusive proof that he was acquainted with a large of floating legend which he has not embodied in his poems. The name Kronides, as given to Zeus, shows that he knew the myths which told of successive dynasties of gods, and knew, therefore, probably the story of Prometheus. Paris in the *Iliad* is, for the most part, mean and effeminate; but his epithet, Alexandros (*helper of men*), attests the existence of legends which give him a different character. His acquaintance with the death of Achilleus is shown only in some passing expressions, unless we assume that the whole *Iliad* was written by a single poet, and that this poet was also the author of the *Odyssey*. His assertion that the Trojan war was caused by the woes and wrongs of Helen, is at once the proof that he knew of legends relating those wrongs and the events which led to them. We are left free, therefore, to analyse a legend which is throughout of singular importance and interest in comparative mythology.

Before the birth of Paris, Hecabê (Hecuba), the daughter (according to one version) of the river-god Sangarios, and wife of Podarkês, otherwise called Priam, dreamt that she gave birth to a kindled torch, which set on fire and destroyed the city of Ilion. The soothsayers being summoned to interpret the vision, ordered the exposure of the child, who immediately after his birth was left on the slopes of Mount Ida. Here a she-bear suckled him for five days, when the shepherd who had brought him from Ilion, finding him still alive, took him to his own home, and called him Paris. (Apollodorus iii. 11, 5.) The child grew up both beautiful and brave, and his defence of the shepherds and their flocks against beasts and robbers won for him the epithet Alexandros. The mode in which his parentage was discovered is related by Hyginus. Priam, thinking that his son was dead, ordered the celebration of funeral games, in which a bull was to be the reward of the victor. The servants took for this purpose the favourite bull of Paris, who followed the men, took part in the games, and, winning the prize, roused the wrath of his brothers, who drew their swords against him. Upon this Cassandra, the prophetess, told them who the stranger was, and Priam acknowledged him as his son. Paris then married Œnônê, the daughter of the river-god Kebrên, and with her dwelt in the dells of Ida. By her he was warned never to go to the land of Helen; but Œnônê promised that if he should do so, and it should turn out to his hurt, she would heal his wound if he came back to her.

The way in which the disaster dreaded by her was brought about links the tale with the legends of Achilleus. To the celebration of the marriage of his father Peleus with the sea-nymph Thetis, all the gods were invited, with the exception of Eris, who threw upon the banquet-table an apple inscribed 'For the

fairest,' and caused a rivalry between HERA, APHRODITÊ, and Athênê [MINERVA], for the possession of the golden prize. By the bidding of Zeus the dispute was referred to the judgment of Paris, into whose presence the goddesses were led by Hermes. There Hera promised him power, Athênê wisdom, and Aphroditê the possession of Helen. Paris gave the prize to Aphroditê; and when Menelaos came to Troy to fetch away the bones of the children of PROMETHEUS, in order to remove a famine sent by the wrath of the gods, Paris accompanied him into the Achæan land, and at Sparta was fascinated by the glorious beauty of Helen, whom he led away, a willing or unwilling captive (for the legends on this point are very conflicting), to his home in Ilion, whither, under the leadership of Agamemnon, Menelaos, and Achilleus, aided by other chieftains, the Achæans came to exact restitution or to take vengeance. But the glory of Paris was clouded. He either refuses to come forth and fight, or, appearing but for a moment, retreats with shame and dishonour. In the issue, he avenges the death of his brother Hector by the slaughter of Achilleus, and is himself wounded by one of the poisoned arrows bequeathed to PHILOCTETES by Heracles. The last scene exhibits the meeting of Paris on the slopes of Ida with the forsaken Œnônê, who in one version will not, or, as in another tale at once more true and more beautiful, cannot, heal him. The arrow of Heracles has done its work too well. Paris is dead, and Œnônê, tender and forgiving to the last, lies down to die on the funeral pile by his side.

The parallelism between this myth and other legends common to the Greek, Teutonic, Scandinavian, and Persian mythologies, is obvious and striking. There is, in fact, scarcely a single incident which may not be matched in other tales with which their affinity was never suspected. The torch seen in Hecabê's dream reappears in the legend of MELEAGROS: it is the gleaming torch of Helios, the sun, with which the life of the hero is bound up (for when the torch is extinguished, Meleagros dies), or which, like the chariot of Phaethon, may scorch and ruin the lands over which it passes. If Paris is destined to bring hurt to his parents, so also are PERSEUS, TELEPHOS, ŒDIPUS, Cyrus, Romulus, Chandragupta, and a host of others. In all these cases, as in that of Paris, the child is exposed, generally on a hill-side, and is always nourished by a wild beast, as a wolf, a dog, or a she-bear; but these animals may all be resolved into phrases of solar myths. The confusion between the words for light (lux, λευκός) with the name for a wolf (λύκος) has been noticed under LYCAON; the dog is the hound which attends Artemis, the sister of the sun-god Phœbus; the bear carries us at once to the story of the Seven RISHIS, and shows the same change of form caused by the same confusion of words which gave rise to the stories of Lycaon, Arcas, and Callisto. The mode in which the parentage of Paris is discovered agrees closely with the legends of Cyrus and ROMULUS. His love for Œnônê is the love of Heracles for Iolê, of Odysseus for PENELOPÊ, of SIGURDR for Brenhyldr in the Volsung tale. All these are separated from or desert their first love. Sigurdr forsakes Brenhyldr for the daughter of Gunnar. Heracles must leave Iolê, and dwell for a time with Deianeira and other women in distant lands, and Odysseus must sojourn far away from Penelopê; but though for a time they may forget, they are still loved by those whom they have forsaken, and in their last hour they are all united with them, Achilles with Brisêis, Heracles with Iolê, Odysseus with Penelopê, Sigurdr with Brenhyldr. When Paris comes back wounded with the fatal arrow, Œnônê, although, like Iolê by the funeral pile of Heracles, she may soothe his last moments, cannot heal his wound. The fair hues of evening look on the dying sun, but they cannot check the approach of night. Like Brenhyldr and Cleopatra, Œnônê dies by the side of Paris; the brides of the sun cannot long survive his setting; and the tragedy of nature was realised by a more tragic symbolism in the Hindu rite of SUTTEE.

This parallelism might be drawn out in much greater detail; but the characteristics which such heroes as Achilleus, Meleagros, and Paris exhibit in common must not be left unnoticed. Each of these is famed for brilliant exploits; the action of each is partly beneficent and in part hurtful; each is roused to anger on slight provocation; each is moody, sullen, and capricious; each in the times of inaction sits in his house or his tent burnishing his golden armour; each is roused to activity by the pleading of a woman; each is doomed to an untimely death; and the features exhibited in germ in the story of Meleagros (*Iliad* ix. 380) only need expansion in order to furnish every incident in the myths of Paris and Achilleus.

What, then, is the source of this myth? and is Paris, like the others already mentioned, a solar hero? This question is still a subject of controversy; but the answer may perhaps be found by a comparison of this myth with that of HERMES. The name PARIS is etymologically the same as that of the Vedic Pânis, the representatives of the dark powers of night, who steal the cattle of Indra (the sun). In the same way, the name of Helen is identified with that of Saramâ, the messenger of the gods to the Pânis, sent to bring back the stolen cattle; the change of letters being illustrated by the Greek Erinys and Χάριτες, as compared with the Sanscrit Sarynyu and Harits, the Dawn and the horses of the Indra. The negative argument from the digamma is not available; as the digamma represents in the cognate languages at least three different letters, *v*, *s*, *y*; thus in ἕξ it represents a lost *s*, as is proved by the Latin *sex*, six. But Saramâ, wherever she appears in the Vedic poems, appears as the Dawn (Max Müller, *Lectures on Language*, 2nd series, xi.); and the Pânis seek to make her

faithless to the charge given to her by Indra. In the earlier form of the tale, she resists the temptation; in the later version, she yields so far as to accept from them some milk—the first sign of that faithlessness which was to expand into the tale of Troy. In the index to the *Rigveda-Sankitâ*, Saramâ is spoken of as the hound of the gods: and it may be noticed that in the *Iliad* Helen calls herself a dog, although the name is never applied to her by others. From all these facts, the conclusion of Prof. Max Müller is that Helen is the counterpart of Saramâ, the dawn-light, and Paris that of the Pânis, the gloomy darkness. But although there can be no doubt that this is the idea embodied in the Vedic Pânis, the affinity of the Greek Paris to the solar heroes seems to be proved by cogent evidence. As the Vedic idea of Saramâ (the dawn with its early breeze) grew in Greek hands into that legend of Hermes every incident of which is the expression of air in motion, so there is not a feature in the legend of Paris (as related in the Homeric poems or by the mythographers) which is not found in the solar heroes, and not one which is attributed to the beings who in Greek mythology really represent the darkness and gloom of night. The very epithet γυναιμανής, the special characteristic of Paris, is in the Vedic hymns applied not to the Pânis but to Indra, who is spoken of as *the lover of the maidens, the husband of the brides*. The treachery of Paris is no argument against the solar character which he assumed under Greek hands, but which he had not possessed originally. Heracles is a seducer not less than Paris; and his faithlessness is repeated even in the Teutonic Sigurdr. In this change from the original idea we see simply the results which must inevitably follow the disintegration of myths, and which in Hermes has substituted the idea of wind for that of light, and has given to Orthros the double character of the early dawn and of the antagonistic power of darkness. [NEMESIS; VRITRA.]

Paris Tertiary Group. The name given by Mr. Prestwich to the middle eocene deposits, as distinguished from the name *London Tertiary Group* applied to the LOWER EOCENE or LONDON CLAY series.

The rich fauna of the *Calcaire grossier*, accompanied by a profusion of Nummulites (absent in the lower beds), is very characteristic of this part of the series. The thickness of the beds is, however, inferior to that of the same series in England. Upwards of 800 species of fossils have been named from the Paris beds, and they include a great variety of genera. [EOCENE; MIDDLE EOCENE.]

Parish (Gr. παροικία, *a neighbourhood*). Properly, an ecclesiastical division of a town or district subject to the ministry of one pastor. In the earliest ages of the church, the parochia was the district placed under the superintendence of the bishop, and was equivalent to the diocese. It denoted, says Bingham, not only what we now call a parish church, but a city with its adjacent towns or country regions. It was not until the Christians became sufficiently numerous to present distinct congregations in the smaller towns and villages, that the bishop appointed his presbyters to reside among them, and thus subdivided his diocese into several parishes. This constitution is recognised in several councils and other monuments of the fifth century. It is, indeed, probable that in many cities there existed more than one church and congregation even in the earliest times; but it does not appear whether these deserved the name of parishes, as being each under the distinct superintendence of its respective pastor. But although parishes were originally ecclesiastical divisions, they may now be more properly considered as coming under the class of civil divisions; and consequently claim our attention under this head. It is not easy to determine the era of the division of England into parishes; they are mentioned in the laws of King Edgar so early as 970, when the whole kingdom seems to have been divided into parishes; but it is probable that the division was not made at once, but by degrees. It is, according to Blackstone, pretty clear and certain that the boundaries of parishes were originally ascertained by those of manors; for it very seldom happens that a manor extends itself over more parishes than one, though there are often many manors in one parish. The parochial division of England was nearly the same in the reign of Edward I. (1272–1307) as at present.

Parishes are frequently intermixed with one another. This seems to have arisen from the lord of the manor having had a parcel of land detached from the main part of his estate, but not sufficient to form a parish of itself. It was natural for him to endow the church which he had erected upon his principal estate with the tithes of these disjointed lands; especially if it happened that there was no church in any lordship adjoining to them.

The boundaries of parishes depend on immemorial custom; but it is probable that they were not settled with very minute precision till the introduction of the poor laws, when, in consequence of the claim for relief upon their particular parishes given to the poor, it became a matter of consequence to define exactly the limits of each parish. They cannot now be altered except by legislative enactment.

In the northern counties, where the parishes sometimes embrace thirty or forty square miles, the poor laws, the due administration of which must always depend on an intimate knowledge of the situation and character of everyone applying for relief, could not be properly carried into effect. To remedy this inconvenience, an Act was passed in the 13th of Charles II. permitting townships and villages, though not entire parishes, severally and distinctly to maintain their own poor. Hence townships in the north of England may be regarded as divisions subordinate to parishes, and are, in practice, as distinctly limited as if they were separate parishes.

Besides parishes or townships, there are places which are deemed extra-parochial, or not within the limits of any parish. These were formerly the sites of religious houses, or of castles the owners of which would not permit any interference with their rights. They enjoyed some most valuable privileges: among others, a virtual exemption from the poor rate, because there was no overseer on whom the order of a magistrate might be served—from the militia laws, because there was no constable to make the return—and from repairing the highways, because there was no surveyor; but these have been in great measure abolished by recent legislation (20 Vict. c. 19, as to poor; 25 & 26 Vict. c. 61, c. 32, as to highways). Their tithes are, by immemorial custom, payable to the king. The number of such places is not inconsiderable, amounting to more than 200. Extra-parochial wastes and marsh lands, when improved and drained, are assessed to all parochial rates in the parish next adjoining. In some counties, *liberties* interrupt the general course of law as affecting hundreds, as extraparochial places interrupt it with regard to parishes. This inconvenience is particularly felt in Dorsetshire. The number of parishes and parochial chapelries in England and Wales is not exactly ascertained; but there are not many doubtful cases, and for any general purpose they may safely be taken at 10,700. About 550 parishes extended in 1851 into two counties, or into more than one hundred or other divisions. (Blackstone's *Commentaries*, Introd. sec. 4.)

The parishes of Scotland are purely ecclesiastical. [PRESBYTERY.]

Parish Clerk. The name of one of the inferior functionaries of the English church. Parish clerks are regarded by the common law as persons having freeholds in their office. In former times parish clerks were frequently in orders, and even at present this is sometimes the case. They are generally appointed by the incumbent, but by custom may be chosen by the inhabitants.

Parisite. A rare mineral occurring in elongated double six-sided pyramids, of a greenish or brownish-yellow colour with a tinge of red, at the emerald mines of the Muzo Valley, in New Granada. It contains cerium, lanthanum, didymium, fluoride of calcium, &c. Named after the discoverer, J. J. Paris.

Paritium (from Paríti, its Malabar name). To this genus of *Malvaceæ* we owe the Cuba Bark, a material used for tying round bundles of genuine Havannah cigars, and also much employed by gardeners for tying purposes as a substitute for the bast formed of the bark of the Linden obtained from Russia mats. The tree is found in the West Indies, and is the Mahoe of the colonists, the *Paritium elatum* of botanists. *P. tiliaceum*, the Paríti of Malabar, also yields a fibrous bark which is made into fine matting, cordage, packthread, &c.

Park (A.-Sax. pearroc, Ger. pferch). A considerable extent of pasture and wood land surrounding or adjoining the country residence of a man of wealth, devoted to purposes of recreation or enjoyment, but chiefly to the support of a herd of deer, though sometimes to cattle and sheep. Parks were originally nothing more than portions of forest appropriated by the lord of the soil for the exclusive use of animals of the chase; but this is now in many cases a secondary consideration, and the chief uses of a park are as indications of wealth and extent of territory, and as grazing ground for domesticated animals.

Park of Artillery. The place where the ordnance of an army, with its carriages, ammunition, and artillery stores, are kept, as near to the ground on which the batteries are to be placed as is consistent with safety. The parks are supplied from the artillery dépôts, which are generally near the base of operations.

Parkia (after Mungo Park, the African traveller). A genus of *Leguminosæ*. The African Locust-tree, *P. africana*, yields seeds which after preparation are eaten. They are roasted, then bruised, and allowed to ferment in water till they become putrid, when they are washed, pounded, and made into cakes, which are said to form an excellent sauce for all kinds of food, but have an unpleasant smell. An agreeable beverage is made from the sweet farinaceous pulp by which the seeds are surrounded. The tree grows from thirty to forty feet high.

Parkinsonia (after Parkinson, an ancient writer on plants). A genus of *Leguminosæ*, one species of which, *P. aculeata*, the Jerusalem Thorn of the West Indies, is used for making hedges, and is also employed as a febrifuge.

Parksine. A material similar to ebonite, made by incorporating together castor oil and a solution of gun cotton in wood spirit. The mixture gradually solidifies to a hard and compact mass, and during its passage through a pasty condition may be moulded like Indian rubber or gutta percha into any required form. It has been proposed as a substitute for caoutchouc and gutta percha in the manufacture of electric telegraph cables, and for ebonite in that of combs, bracelets, &c.

Parliament (Mod. Lat. parliamentum, Fr. parlement, from Fr. parler, *to speak*). The supreme legislative assembly of Great Britain and Ireland.

Origin of Parliament.—By the principles of the feudal system, every sovereign and every great feudatory had his council, composed of his greater and lesser vassals, which occasionally assembled to assist him both in judicial and legislative matters; and which was held in theory to be permanent, so that its assent was necessary to the validity of his acts. It was also an ancient custom, in several of the western kingdoms of Europe, for such potentates to hold assemblies of their barons at the great festivals of the year, termed *cours plénières* and *parlemens*; principally, however, if not entirely, for the mere purpose of show and magnificence. But occasionally such special assemblies were

summoned for more important purposes; and the meeting in 1146, at which the crusade of St. Louis was undertaken, is said to furnish the first occasion in which the word *parliament* is used for a deliberative assembly. In France, however, the word was afterwards transferred to signify the principal judicial courts of that country. The only realms in which it appears to have become appropriated to the great legislative assemblies are England, Scotland, and the Norman kingdom of Sicily. The parliament of the latter country consisted, in the thirteenth century, of spiritual and temporal barons summoned by the king's writ; and occasionally, but not uniformly, of deputies from the towns, similarly summoned.

The Norman and Plantagenet kings of England had two councils—the great council of the kingdom, and the lesser or privy council; and it may be freely stated, after making all allowances on the score of arbitrary powers occasionally exercised by the sovereign, that ever since the Norman Conquest the supreme legislative power in England has been placed in the king and great council conjointly. This council was, moreover, in early times, a court of criminal judicature also, and aided the sovereign in all the more important transactions of his government. It interfered even in matters of ecclesiastical discipline; in questions of peace and war, of grace and justice; and, by way of advice, in the appointment to vacant offices, civil or ecclesiastical. The meetings of the great council were at stated festivals under the Norman kings; but after the civil wars in the reign of Stephen they were summoned at irregular periods. The inferior or privy council, which, as well as the great council, is indifferently termed *curia regis* in early writers, was composed of members named by the king, and constantly attended on his person; and this inferior body usurped, during the decadence of the great council, and before the full establishment of parliament, many of the legislative functions of the former; but by Magna Charta all aids and scutages were to be assessed by the great council; which thus, in principle at least, possessed a control over the extraordinary revenues of the crown. Any meeting of the great council, or of a portion of it, went by the ordinary name of a *parliament* or colloquy.

But of the constituent parts of this assembly, and the changes which took place in it, no writers give a satisfactory account. We know only that it was supposed to consist of all the tenants in chief of the crown; but, by the charter of King John, the archbishops, bishops, abbots, earls, and greater barons, were to be summoned personally; the other tenants in chief by the sheriffs and bailiffs. From this distinction is supposed to have arisen the institution of the peerage as a separate body from the lesser nobility, which so peculiarly distinguishes the constitution of England from those of all other feudal monarchies.

From these mixed assemblies to a representative body the change proceeded by steps which it is impossible wholly to trace. The first vestiges, perhaps, of representation, appear in the fifteenth year of King John, when, for a particular purpose, writs were issued to the sheriffs, commanding them to return four knights for each county, 'ad loquendum cum rege de negotio regni,' at Oxford. But better known and more distinct evidence of the beginning of the system is found in the earl of Leicester's parliament after the battle of Lewes, in 49 Hen. III., when four knights for every county (except nine) were summoned to attend with the barons, probably as representatives of the inferior nobility or lesser barons; and in the following years were issued the earliest writs of summons to parliament. These were to archbishops, bishops, and abbots; to certain earls and barons of the party of the earl of Leicester; and to the sheriffs of counties and boroughs, to return two knights and burgesses, besides four from each of the Cinque Ports. And although no subsequent writs directed to the sheriffs for the purpose of county elections are in existence earlier than 18 Edw. I., nor of borough elections earlier than the 23rd of the same reign, yet it is at least highly probable that the example set by the rebellious earl of Leicester was ever after substantially followed, and that the representatives of counties and towns were occasionally summoned to parliament, as well for the purpose of assessing tallage and other aids demanded, as for that of giving their counsel respecting other affairs of the government. Edward I. usually held four parliaments in a year; but it does not appear that these were legislative assemblies; they were rather supreme courts of justice, chiefly attended by the ordinary or privy councillors of the king; while the legislative assembly, certainly composed, after the 23rd of this reign, of lords spiritual and temporal and representatives of the commons, was summoned to meet the king occasionally during one of these parliaments. (*Report on the Dignity of a Peer.*)

The constitutional law of the country, whatever it may have been in practice, was first declared by the statute 15 Edw. II. In this Act the legislative authority was declared to reside in the king, with the assent of the prelates, earls, barons, and commons, assembled in parliament; and from that time the real existence of that body, and of the form of government still subsisting has been uninterrupted, except only during the period of the Commonwealth.

The division of parliament into two houses took place at a period which it is not possible to ascertain; but it is probable that the three orders met in separate conventions for the purpose of assessing taxation, and that the representatives of the commons were at no period admitted to sit in the same chamber with the earls and barons after these were expressly summoned by the king. Although the numbers of both houses have varied materially, no fundamental alteration in their constitution took place from this time until the union with Scotland.

House of Lords.—1. *Temporal Peers.* The origin of the English peerage is involved in the same obscurity which rests on other parts of our early constitutional history. The greater barons, as before stated, appear under the first Plantagenet kings to have been those who were personally summoned to the council, while inferior tenants in capite were summoned together by a general compellation; but at what period their dignity became strictly hereditary is unknown.

Baronies are either by tenure, by writ, or by patent. The first were the original feudal titles, in which dignity was invariably attached to the possession of land. The greater barons, who sat of right in the great council, are supposed up to the reign of Henry III. to have been those who were in the possession of entire baronies. But from the date of 22 Edw. I. it appears that the possessors of entire baronies ceased to be summoned to parliament as of right; and it is generally held that no barony by tenure subsists at the present day, although some recent efforts have been made to establish a title to this peculiar dignity; the latest claim having been that made in 1860 on the barony of Berkeley, by virtue of possession of the castle of that name.

Baronies by writ were created by writ of summons to parliament, which constituted an individual so addressed by name baron of the realm, and, it is supposed, also made that dignity hereditary. The earliest writ of this description was issued 49 Hen. III.; and two now existing baronies (Le Despencer and De Ros) are considered to have been created by it. In the case of a barony by writ, the dignity is not conferred until the person so summoned has actually sat in parliament. Baronies by writ descend in fee to all the heirs of the body of the person first created. If there be no son, and more daughters than one, the title falls into abeyance until only one daughter, or the sole heir of only one daughter, survives.

Baronies by patent are created by letters patent, under the great seal, conferring the dignity on the donee; in which are inserted words of limitation. These are usually to the heirs male of the body of the donee, though the limitation may be to other classes of heirs, or to specified persons, and their heirs by way of remainder. It was decided by the House of Lords, in the Wensleydale peerage case in 1856, that a peerage could not be granted for life only.

Viscounts are always created by letters patent. This is the most modern of English titles of peerage; and was first conferred on John Viscount Beaumont, by Hen. VI. in 1440. The title vice-comes, or vice-earl, has been long employed to denote the sheriff of a county.

Earldoms existed in England before the Conquest. But the Saxon *ealdorman* was the official governor of a shire, and his office was not necessarily continued to his son. The Danish title of *eorle* was gradually substituted for that of ealdorman. After the Conquest the Norman term *count* (whence *county*) took the place of *earl*, but the latter title was soon revived. It has now for many centuries been disconnected with territorial jurisdiction, and is conferred by letters patent.

Of *Marquisates*, the first was that of Dublin, conferred on Robert de Vere, earl of Oxford, for life, by Richard II. This dignity has been always conferred by letters patent.

Dukedoms are the highest titles of the English peerage. The first was created 11 Edw. III., when Edward the Black Prince was made duke of Cornwall. It has been a question whether the duchies of Cornwall and Lancaster were not duchies by tenure; but every other dukedom is a mere personal honour, and conferred by letters patent. [Baron; Viscount; &c.]

All peerages are forfeited by attainder for high treason; and attainder is consequent either on judgment or on outlawry, upon an indictment for that offence. Nothing but a reversal of such act of attainder by parliament can restore an attainted person, or his posterity, to the lost dignity. But where a peerage is vested in a person in tail male, with remainder over to another in tail male, if the first be attainted the peerage is forfeited as to him and his issue male; but, failing such issue male, the dignity becomes vested in the remainder-man, or his descendant.

Peerages descendible to heirs general are also forfeited by attainder for felony; but not peerages entailed on heirs male.

By the twenty-second and twenty-third articles of the Union between England and Scotland, sixteen representatives are elected by the Scots peers to serve in every parliament of the United Kingdom. Scottish peers are incapable of sitting in the House of Commons, and it was held for a long time that a Scottish peer could not sit in the House of Lords if he became a peer of Great Britain; but the point was decided the other way in 1780.

By the Act of Union between Great Britain and Ireland (39 & 40 Geo. III. c. 67), twenty-eight lords temporal are elected for life by the peers of Ireland. Peers of Ireland may be elected members of the House of Commons, but are not eligible to serve as peers while they continue members of the lower house.

2. *Lords Spiritual.*—The right of the two archbishops and twenty-four bishops of England and Wales to sit and vote in parliament as members of the House of Lords, is generally said to belong to them as barons of the realm. It is undoubtedly probable that at the period of the Conquest a change took place in the tenure of the lands which were held by bishops and the high regular clergy; and that the Norman tenure by barony, then introduced for the first time, was made to comprehend both spiritual and temporal possessions, which under the Saxon kings had been regarded in a different light. But it is most probable that the dignitaries of the church were constituent members of the great council of the realm, by the English as well as all other feudal consti-

tutions, independent of their quality as barons (Hallam, *Middle Ages*, c. viii. part iii.); but that the place which was assigned them in the House of Lords, when the two houses became separate, was in virtue of their baronial character. Under the Plantagenet kings the clergy were summoned to meet by their representatives, as well as the laity, when subsidies were required; and under Edward I. attempts were made to unite them and the laity together in parliament; but this was always resisted by the clergy, who at last ceased altogether to attend in any capacity, retaining their own assemblies. [CONVOCATION.] At the period of the dissolution of monasteries by Henry VIII. the spiritual lords consisted of the then archbishops and bishops, with twenty-six mitred abbots, and two priors, all of whom were removed on the dissolution of their houses. The whole number of English bishops is now twenty-six; but only twenty-four of them have seats in the House of Lords, the bishop of Sodor and Man never having had one, and the bishop for the time being last elected (except to the sees of London, Durham, or Winchester) having also been excluded since the number of bishops was augmented by the erection of the see of Manchester (10 & 11 Vict. c. 108). The present spiritual lords have the same rights and privileges in every respect as the temporal, except that it is still a disputed point in constitutional law whether they have a right, on charge of treason and felony, to a trial by the peers; and it is also doubted whether they have judicial power, as peers, in capital cases.

By the Act of Union between Great Britain and Ireland, four lords spiritual from among the archbishops and bishops of that country sit in the House of Lords by rotation of session.

HOUSE OF COMMONS.—I. *Persons qualified to serve in it.*—Persons incompetent to sit as members of parliament are, first, those labouring under the incapacities of alienship, attaint, outlawry in criminal proceedings, minority, lunacy, &c.; next, those who are disqualified by the possession of certain offices, or by certain other temporary causes. By the Corrupt Practices Prevention Act, 1854, it is provided that any candidate declared by a committee guilty of bribery, &c. is ineligible during that parliament. Clergymen (including the Roman Catholic clergy and also ministers of the church of Scotland), peers, Scotch peers, Irish peers as to places in Ireland, the English, Scotch, and Irish judges (with the exception of the English Master of the Rolls), county court judges, and bankruptcy commissioners, are ineligible. Where the influence of government is supposed to have a direct control over the party, a disqualification has been created by various statutes. Persons concerned in the management of the revenue, with some few exceptions, are ineligible. So are persons holding new offices under the crown created since 1705, together with other persons mentioned in 6 Anne c. 7. So also are pensioners during pleasure or for a term of years, police magistrates, government contractors, and placemen in public offices specified in 15 Geo. II. c. 22. There are also offices connected with the excise and customs which disqualify the holder from sitting and voting, but not from being elected. Persons returned on a double return are not competent to sit until the right to the seat has been determined. The property qualification of members of parliament was abolished in 1858 (21 & 22 Vict. c. 26).

The acceptance of any office of profit from the crown by a member vacates his seat, by 6 Anne c. 7. And there are places of no profit, the acceptance of which is considered to vacate a seat; viz. the stewardship of the Chiltern Hundreds, and the stewardship of the manors of East Hendred, Northstead and Hempholme, and in Ireland the office of Escheator of Munster (21 & 22 Vict. c. 110). Officers of the army and navy receiving new commissions are excepted from this statute; so are those who accept a foreign employment, as ambassadors.

A member becoming a bankrupt is incapable of sitting and voting for a year, unless within that time the bankruptcy is superseded, or the creditors paid; if this be not done within the year, the seat of the member is vacated.

Whether a resolution of the house can render a person ineligible, may still be considered as an undecided question.

II. *Electoral Franchise.*—Since the Acts of Union with Scotland and Ireland, and the changes introduced by the Reform Act, and subsequently, the House of Commons consists of 658—divided as follows:

	English and Welsh	Scotch	Irish
Counties . . .	162	30	64
Boroughs . . .	334	23	39
Universities—Oxford .	2		Dublin 2
Cambridge	2		
	500	53	105

All persons qualified are competent to vote in the election of members of parliament, except infants, women, aliens (unless made denizens or naturalised), persons convicted of felony, bribery, &c., peers, Irish peers unless themselves members of the House of Commons, and persons holding various employments under government not freehold offices. There are also some temporary disqualifications, arising out of employment in particular characters at elections, and the receipt of public alms. The qualification (except in the universities, in which the right of voting belongs to all such as have attained certain academical degrees) is one of property.

1. In English and Welsh counties, the right of voting belongs to all such as possess a freehold estate in lands or tenements, of the value of 40*s*. per annum above all charges; or who are seised of lands or tenements in copyhold, or any other non-freehold tenure for life, or for a larger estate of the value of 10*l*. per annum; or entitled as lessee or assignee to lands or tenements for the unexpired residue of a term of not less than sixty years of the same value, or of a term of not less

than twenty years of the value of 50*l.* per annum; and occupiers of land and tenements at a bonâ fide rent of 50*l.* or more per annum. But freehold tenements for life, if under the value of 10*l.* per annum, do not confer a vote, unless the party is in the actual occupation of them, or unless they have come to him by devise, marriage, &c., and not by gift or sale. And in the case of freeholds and copyholds, possession for six months before the last day of July in the year in which the voter is registered, is a necessary condition; in that of leaseholds, &c. twelve months; but this does not apply to lands coming by devise, marriage, &c.

2. The qualifications of voters in cities and boroughs, in England, were, under the law as it stood before the Reform Act, extremely various, and depending more on the local law of every place than on the general custom of the country. The principal franchises were: (1.) In respect of property; thus freeholders to the amount of 40*s.* voted in many towns and cities which were counties of themselves; leaseholders, copyholders, &c., in other places; and burgage tenants. The franchise of burgage tenure, which existed in some towns, depended on the possession of certain ancient tenements, which conferred a right to vote. (2.) In respect of corporate privileges. Freemen or burgesses, and, in London, liverymen [CORPORATION], enjoyed by virtue of their privilege a right of voting in corporate towns. (3.) In respect of inhabitancy. Voters in this respect were of four sorts: inhabitants paying scot and lot; inhabitants householders, housekeepers, potwallers (i.e. pot-boilers), legally settled; inhabitants householders resiant; inhabitants generally. In many towns, several of these qualifications were recognised at the same time as conferring a right to vote.

The alterations introduced into the system of borough qualifications by the English Reform Act were twofold. In the first place, a new franchise was created which is everywhere the same. Every capable person who occupies within the limits of a borough any house or building falling within the specifications of the Act, which is, either separately, or jointly with land occupied therewith by him as owner, or under the same landlord, of the clear yearly value of 10*l.*, is entitled to vote; provided he has occupied such premises for twelve months previous to the last day of July in the year in which he is registered; and provided he has been rated, and paid all rates for the benefit of the poor due up to the 5th of January next preceding, and also all assessed taxes. In the next place, former franchises are modified as follows: Freemen, and in cities being counties of themselves, freeholders and burgage tenants, are to retain their qualification (subject in the latter case to certain restrictions as to value, &c.); but no one can claim to be registered as a burgess or freeman who was admitted since the 1st of March, 1831, except he derive his title through birth or servitude. All other borough franchises are abolished, saving their rights to individuals possessed of them at the passing of the Reform Act.

Finally, the Act requires that every person, in order to be registered as a voter for a city or borough, must have resided for six calendar months next previously to the last day of July in that year within such city or borough, or within seven miles of it. And it is also provided, that no tenement situate within a borough, and capable of conferring a qualification on its occupier to vote within the borough, shall give him a vote for the county.

Several boroughs in Wales, as well as in Scotland, are *contributory*; several towns being joined in one for the purpose of returning members to parliament.

The system of registration of voters, in England and Wales, was framed by the Reform Act, but is now regulated by stats. 6 & 7 Vict. c. 18 and 28 & 29 Vict. c. 36. *In counties*, the register is made up by the overseers of the poor in every parish or township, who insert therein the names of all persons not already registered who have delivered to them, before the 20th of July in each year, a claim to vote in respect of property situate within their district. The lists thus drawn up by the overseers, are delivered to the clerk of the peace for the county. The overseers are empowered to object to any person on their list whom they conceive not entitled to vote. They are also to receive written notices of objection by third parties, who are themselves voters or claimants, duly delivered to them, and to mark the names of all parties so objected to on the list. The lists thus formed are revised by the barrister or barristers appointed for that purpose. These officers are nominated by the senior judge of assize for each county and borough within his circuit; and by the chief justice of the Queen's Bench in the metropolitan county and boroughs. Their courts, for the purpose of revising the lists and deciding on claims and objections, must be held (for counties) between the 20th September and 31st October in every year. The lists revised by them form the register, which is delivered to the sheriff, and is the authentic list of voters until the next registration. Any person having his name and qualification once inserted in the register is not bound to make a claim another year.

In cities and boroughs the course is somewhat different. On or before the last day of July in every year, the overseers are to make out an alphabetical list of persons entitled to vote under the Reform Act; and another of persons entitled to vote in respect of ancient rights (except freemen, the list of whom is to be made by the town clerk, and in London by the clerks of the several companies). Any person whose name has been omitted in either of these lists is to give notice of a claim, in writing, to the overseer or town clerk or other clerk (as the case may require). Objections are to be made, in boroughs, only by parties whose names are inserted in the list. The

lists are revised by the barristers in the same manner as those for the counties, and delivered to the returning officer.

3. In Scotland, the right of voting in counties is declared by the Scotch Reform Act, 2 & 3 Wm. IV. c. 65, to be in the owners of ancient rights (termed *superiorities*) not acquired since 1831, and in such persons as have been owners for six months previous to the last day of July of 'any lands, feu duties, or other heritable subjects,' of the annual value of 10*l.* after deductions. Where two or more parties are interested in any subject to which a right of voting is for the first time attached by the Act, as liferenter and as fiar, the right shall be in the former. The right is also extended to tenants for life, or on lease of fifty-seven years or more, the value of whose interests amounts to 10*l.* per annum; tenants on lease of nineteen years or more, the value of whose interests amounts to 50*l.* per annum; occupying tenants at a rent of 50*l.* per annum; and tenants who have paid for their interest a price of 300*l.*

4. In Scottish boroughs, the right of voting is in occupiers of houses, &c. (as in the English Reform Act) of the yearly value of 10*l.*

5. In Ireland, the right of voting in counties was, by the Irish Reform Act 2 & 3 Wm. IV. c. 88, vested (in addition to the 10*l.* freeholders then already entitled to it) in 10*l.* copyholders, in leaseholders for sixty years the yearly value of whose interest amounted to 10*l.*, in leaseholders for fourteen years the yearly value of whose interest amounted to 20*l.*, and in certain classes of occupying tenants. By stat. 13 & 14 Vict. c. 69 the county franchise was extended to 5*l.* freeholders, and occupiers of land, &c. rated at 12*l.* and upwards.

6. In counties of cities, counties of towns and boroughs in Ireland, the franchise is by the Irish Reform Act in 10*l.* freeholders, 20*l.* leaseholders, 10*l.* householders, and in the 40*s.* freeholders; but not in any persons acquiring such last mentioned freeholds since 1831, except by descent, marriage, &c.; and by the Act 13 & 14 Vict. c. 69 the franchise was extended to occupiers at a rent of 8*l.* and upwards. The existing rights of freemen, &c. are saved.

Both in Scotland and Ireland the registers are made up and revised on the same general system as in England, but with variations in matters of technical detail.

III. *Mode of Election.*—1. In England and Wales, when the sheriff receives the writ commanding him to return a knight or knight of the shire, or division of the shire, he makes proclamation, within two days after receiving the writ, at the place where the election is to be holden: i.e. the principal polling place. Counties and divisions are subdivided into convenient districts, with a polling place in each. On the day fixed, the candidates are proposed; and the election proceeds. In boroughs, the returning officer acts in the same manner as the sheriff in the county; and boroughs are similarly divided into polling districts.

When more candidates are proposed than the number to be returned, the election is decided by the sheriff or returning officer declaring the majority on the view (by calling on them to hold up their hands). But a poll may be demanded by a candidate or elector, either before or after such declaration.

The poll commences in boroughs on the next day, in counties on the next day but two, after the nomination. Two questions only can be asked of any person offering to vote as to his right: (1) whether he is the same person whose name appears on the register, and (2) whether he has already voted. The duration of the poll in England is limited, both for counties and boroughs, to a single day, and in the English universities to five days. The return is made by tacking the names of the persons chosen to the writ and returning them to the clerk of the crown in chancery. Where the votes are equal, it is the practice to make double returns.

2. In Scotland and Ireland, the period of polling is also a single day.

Electors for the English and Irish universities are now allowed to vote by voting papers (24 & 25 Vict. c. 53).

IV. *Election Committees.*—In the first parliament of James I. a committee of privileges and returns was appointed, to which the trial of every petition against an election was referred which was not heard before the House of Commons. A similar committee was appointed at the commencement of every session, until the present practice of trying such petitions before select committees began. This practice is founded on a variety of statutes, beginning with 10 Geo. III. c. 16, commonly called the Grenville Act, and amended and consolidated by 11 & 12 Vict. c. 98, which is now the governing Act on the subject. Under this Act there are three classes of election petitions: Those complaining (1) of an undue election or return; (2) that no return has been made according to the requisition of the writ; (3) of the special matters contained in the return. Any such petition must be subscribed by (1) some person who voted or had a right to vote at the election, (2) some person claiming to have had a right to be returned or elected at the election, or by (3) some person alleging himself to have been a candidate at the election. The Act also contains provisions by which electors in the interest of any sitting member who may be unable or unwilling to defend his seat are admitted to defend the election or return.

An election petition is presented to the house by a member within a certain time limited by the house. But before presentation the petitioner must procure a recognisance to be entered into by sureties on his behalf for the payment of 1,000*l* or must pay that sum into the Bank of England as a security for costs. Petitions once presented can be withdrawn by the petitioners on payment of the costs and expenses incurred by the sitting member.

Under the Grenville Act election petitions

were taken into consideration by the house at a time appointed for that purpose, and at that time, if one hundred members were present, the parties and agents attending, thirty-three were selected by ballot; which number, on each party striking off one alternately, was reduced to eleven. But according to the present practice a general committee of elections is appointed by the Speaker at the beginning of every session. This general committee chooses four members to form a select committee to try an election petition, out of the whole list of members liable to serve, which for that purpose is divided into five *panels*, and a chairman for the committee is chosen by and out of a separate panel, called the *chairmen's panel*.

The same nicety, it is said, is not required in election petitions, as to their form, as in pleadings at law; but it is now decided, by a series of precedents, that it is necessary that the matter intended to be proved should be sufficiently set forth in the allegations of the petition; and that on the hearing of the petition it will not be com[ ]etent to the party to go into evidence in [ ] of facts not distinctly alleged therein. But there is considerable variety in the decisions as to what is sufficiency of allegation.

Select committees sit every day; but with power to adjourn for twenty-four hours on their own authority, and for a longer period on leave obtained from the house on motion. Members may only absent themselves by leave, or on excuse to be allowed by the house: if any are absent otherwise, the committee cannot sit. Committees are not dissolved by prorogation of parliament, but adjourned to the next time

The determination of the committee is in each case final and conclusive; and is embodied in its report to the house at the conclusion of its sittings. A committee has also the power, if it pleases, of making a special report, instead of deciding generally on the merits: in which case the house makes such order on the report as may seem proper. An examination into the bad votes given on each side is termed a *scrutiny*; and the effect of it is, that if on balancing the number of good votes retained after such examination the petitioner has the majority, it is reported that he ought to have been returned. Where an incapacitated person has been elected, the principle of parliamentary law appears to be, that if his disqualification was sufficiently known to the electors at the time they returned him, their votes are considered as lost; and it is reported that the next on the poll ought to have been returned. If the fact of his disqualification was not known, the election is simply void. It appears, however, not to be absolutely decided whether the incapacity which renders the votes *thrown away* must be an inherent or contingent incapacity; as, for example, where it was *publicly known* that a candidate was disqualified by reason of having been guilty of acts of bribery with reference to the election. In this case i[t] has been argued that the election is not void, but that the votes given for the person so disqualified are *thrown away*. In other cases, bribery, treating, undue influence, &c. have the effect of avoiding elections; and the report is, that a new writ ought to issue.

Finally, an election committee has the power of declaring either the petition, or the opposition to it, 'frivolous and vexatious' in its report; the effect of which is to fix the party against whom such declaration is made with the payment of costs.

Besides the three classes of petitions above referred to, there is another class presented, under 5 & 6 Vict. c. 102, after the time usually allowed for the reception of election petitions, complaining of 'general or extensive bribery.' These must be signed by some person claiming in such petition to have had a right to vote at the election or to have had a right to be returned or elected thereat, or alleging himself to have been a candidate thereat. Petitions of this class are enquired into, in the same manner as a committee for trying an ordinary election petition, but do not affect the return or seat of the sitting member.

By 15 & 16 Vict. c. 57, if a committee appointed to try an election petition, or to enquire into the existence of corrupt practices at any election, report that there is reason to believe that corrupt practices have extensively prevailed at any election, then on an address by both houses of parliament the crown may appoint commissioners armed with the most stringent powers to enquire into the matter, and the report of such commissioners is laid before parliament.

V. *Mode of Assembling Parliament.*—Parliament can only be convened by the authority of the crown; and, by 6 Wm. & Mary c. 2, must be held at least once every three years; but, in point of fact, as the Mutiny Act is only passed for a single year, and provision is made annually for the public revenue and expenditure, the sittings of parliament are of necessity annual. The same order in council which commands the lord chancellor to cause the great seal to be affixed to a proclamation for dissolving parliament, is accompanied with a warrant to issue writs for a new one. Writs for the return of members of the House of Commons are directed to the sheriffs of counties, and the returning officers of cities and boroughs. On a vacancy during the sitting of parliament, the writ issues under warrant of the Speaker by the authority of the house itself, and the Speaker is empowered by statute to direct the issue of writs on vacancies during a recess.

VI. *Meeting of Parliament. Preliminary Proceedings.*—The new parliament meets on the

despatch [of] business on the day to which it is prorogued, notice to that effect is given by proclamation, and the parliament begins only on the day to

which it is prorogued. The acts of meeting and passing a statute constitute together a session. Upon the assembling of parliament the sovereign meets it in person, or by representation, and explains in his speech the reasons of convening it. In modern times, the speech is not delivered until the commons have chosen a speaker, which they receive a command from the crown to do.

The first occasion on which this important officer is expressly named occurs in the parliament 51 Edw. III. He acts entirely as the servant of the house which appoints him. He takes the chair, which he cannot do unless forty members are present; maintains order; explains and informs on questions of order or practice. He cannot speak except upon questions of order, nor vote unless in case of equality of votes; or in committees of the whole house, where, as soon as the chair is taken, he is reduced to the footing of an ordinary member. [SPEAKER.]

Immediately upon the meeting of every new parliament the requisite oaths are administered to the members; but, previous to being sworn, every person returned is to all intents and purposes a member of the house, except as to the right of voting only. Before the queen's speech is taken into consideration, it is usual to read a bill as a matter of form. The queen's speech being then reported to the house, an address of thanks, as moved or as amended, is returned.

The method of proceeding in making laws is, for the most part, similar in the two houses, but different in public and private bills.

VII. *Method of Proceeding on Bills in general.*—Statutes are divided into public and private; and the distinction arises from the local or personal character of the latter class, and from the payment of fees, which are due on private and not on public Acts. Constitutionally, public Acts are in general such as relate to the kingdom at large; private Acts, to individuals and classes. Judicially, the distinction between the classes is, that the courts of justice are officially bound to notice public Acts; but private Acts must be formally shown or pleaded unless they have a clause to prevent this being necessary. [STATUTE.]

All private bills affecting the peerage must begin with the lords; all bills which, directly or indirectly, impose a charge on the people, must begin with the commons. This class, therefore, includes all bills under which tolls may be levied for private benefit; such as bills for making roads, canals, railways, bridges and enclosure bills. But the increase of private bills in parliament has of late years been so great, that the strict rule in this respect has been recently relaxed, and a considerable number of bills for new railways and the like purposes are now annually first introduced in the lords.

All other private bills may begin with either house indifferently; but, in practice, some private enactments—viz. estate bills, which enlarge or alter the power of individuals in disposing of their property; divorce bills; &c.—begin in the lords; that house, from its judicial character, being supposed to be best fitted for the discussion of similar subjects. On the other hand, bills concerning the parliamentary rights, &c. of particular places, usually commence, by custom, in the commons. There is one instance of a bill which begins with neither house, but with the crown; viz. a bill for a general pardon. Bills are always read in each house, after leave has been given to bring them in, three times before they are passed (with the exception of bills of grace, such as for a general pardon, which are passed on the first reading). The second reading affords the legitimate period for discussion on the principle of the bill. If a bill be rejected, either on the first or second reading, it cannot be again proposed that session. After the second reading, the bill is committed, i.e. referred to a committee of the whole house, and, in some cases, to a select committee. Such a committee requires, in the commons, the presence only of forty members; in the lords, of all members in attendance. In committee the bill is debated clause by clause, with the advantage that members are not restricted, as in a debate of the house, to speaking once. The proper province of the committee is to consider the bill in its details. When the bill has gone through the committee, the chairman reports it to the house, with such amendments as the committee may have made. The house can then agree or disagree with the amendments of the committee. [AMENDMENT.] The bill is afterwards read a third time. A bill thrice read, and passed, admits of no further alteration, except for clerical errors. A bill sent from the commons to the lords is usually read the first time in the latter house on the day on which it is brought; and, when it has passed through the different stages, is sent back to the commons, with the amendments, if any have been made, with which the commons then agree or disagree; the same process, substantially, being followed, vice versâ, where the bill originates with the lords. The amendments returned with a bill from one house to another are taken into separate consideration; and the amendments, if agreed to, are always considered as proceeding from that house in which the bill first originated. If one house cannot agree to the amendments proposed by the other, a conference is usually held between members deputed by each house, the conference being desired by that house which disagrees with the amendments in question. If the house which amends is not satisfied at the first conference with the reasons alleged for its disagreement by the other, it desires another conference; if this too is unsuccessful, what is termed a free conference may be demanded, in which the managers of the conference are not confined to the delivery of written reasons, but may urge their own arguments. If one or more free conferences fail of producing unani

suity, the bill is dropped. It is necessary to observe, that in bills of supply (which originate in the commons) the lords cannot make any except verbal amendments; they must either admit or reject altogether. When a bill has passed both houses, it is deposited in the House of Lords, to wait for the royal assent (except in the case of a bill of supply, which is presented by the Speaker to the throne). The royal assent is given either in person, or by commissioners appointed under the great seal. The bill then becomes a statute, and is printed by the queen's printer. Formerly, too, it was transcribed into the Parliament Roll, but since the year 1849 this practice has been discontinued, and the original Acts have been printed.

VIII. *Method of Proceeding on Private Bills.*—This is regulated by the standing orders of each house of parliament, which lay down a great number of rules of practice, relating to the introduction and passing of private bills, which are of too minute and technical a character to be detailed here. It may, however, be stated generally, that although private bills undergo, for the most part, the same formalities of being read three times in each house, &c. as public bills do, they do not, as a general rule, undergo any discussion in the house itself, it being the practice to refer them as a matter of course to a select committee, before which the promoters and opponents of each bill appear by themselves or their counsel, and evidence on both sides is received. The fate of the bill is, in fact, determined by the report of the select committee, it being very unusual for the house itself to interfere in the matter. The practice is for the committee first to enquire whether the preamble (which states the occasion for the bill) is proved. If the committee report that the preamble is not proved, the bill falls to the ground; but if the preamble is accepted, the clauses are taken seriatim, until the whole matter is disposed of. It was formerly the rule for every question arising upon a private bill to be decided by the select committee itself; but the delay and expense occasioned by this course was very great, and increased annually with the increase of private business. Questions relating to compliance with standing orders, questions of engineering, and the like, have of late years accordingly been relegated to subordinate tribunals of examiners or referees, and this practice may be expected to increase.

IX. *Standing Orders of the House of Commons.*—These are a series of regulations, adopted by way of resolutions of the house at various periods, from 1685 to the present time, relating partly to the internal order, &c. of the house, partly to certain preliminaries and forms required on the introduction of particular bills, both public and private, and to the promulgation of statutes. The most numerous of these relate to private bills, and specify the mode of signing and presenting, the time for delivering notices and their necessary contents, the formalities to be required respecting instruments, and a variety of other particulars. When a resolution is made which is intended to be permanent, it is usual to add the form, 'Ordered that the said resolutions be standing orders of the house.' Standing orders on private bills are sometimes (but only on special application) dispensed with by the house, or further time, &c. given for complying with them.

X. *Rules of Business in the two Houses.*—(1.) *In the House of Commons.* A house for the transaction of business consists of forty members, by an order of the year 1640; and, if a less number be present, the Speaker will not take the chair. This rule extends to committees of the whole house. The Speaker of the House of Commons cannot speak in the house; the Speaker of the House of Lords may. A call of the House of Commons is an expedient to secure attendance for an important occasion; when it is made, members absent without leave may be ordered to be taken into custody. No member can be present on the debate of a bill or other business concerning himself. When the Speaker's mace lies upon the table of the House of Commons, it is a house; when under, a committee; when out of the house, no business can be done; when in the hands of the sergeant at the bar, no motion can be made.

With regard to the manner of speaking and voting in the commons, motions are made, and petitions presented, by a member *in his place.* The member who moves a motion puts it in writing, and delivers it to the Speaker, who, when it has been seconded, puts it to the house; it cannot then be withdrawn except by leave of the house. The *motion to adjourn* is put in order to supersede a motion of which the house is already in possession. The motion *for reading the orders of the day* has equally the effect of superseding the existing question. The motion *for the previous question* has been commonly but mistakenly attributed to Sir Harry Vane, as its inventor. It can take place only in a house, and not in a committee; in which latter the equivalent motion is, *that the chairman do now leave the chair.* The Speaker names the member whom he first perceives to rise in order to speak; but the house is not bound by the Speaker's decision. It is understood to be the rule, that a member may speak even after the question put, if the affirmative voice only has been given, and the negative not yet given. The effect of the Speaker's *naming a member* on the occasion of disorder in the house, is that such member, after being heard, if he pleases, is directed to withdraw, and the house then considers what penalty to inflict. In the commons, votes are given by *ay* and *no*; if a division is demanded, the Speaker (by a resolution of 1603) appoints two tellers on each side to count. Strangers are directed to withdraw, and the doors closed before the question is put. On a division, it was formerly the course for one party to leave the body of the house, while the other remained; though in committee of the whole house the *ayes* went on one side and the *noes* on the other. But

according to present practice both parties retire into separate lobbies provided for that purpose, and are counted as they re-enter the house. The Speaker has the casting vote in a house, the chairman in a committee.

(2.) *In the House of Lords.* The general rules of proceeding in the House of Lords vary little in material points from those adopted by the commons. The Speaker can debate as well as vote. The privilege of the lords to vote by proxy is only by license from the crown. Proxies from spiritual lords are only to spiritual: proxies from temporal only to temporal. No lord can hold more than two proxies. The lord chancellor is ex officio Speaker of the House of Lords; and as he is able to speak and vote, he has no casting vote: the rule, therefore, in case of equality of voices, always is, that the presumption is in favour of the negative side.

Messages between the two houses are sent by one of the clerks at the table. Messages from the crown are of various sorts: those to the commons, to desire any proceeding on their part, are usually written under the royal sign manual; those which are sent when a member of the house is put under arrest on account of the public service are verbal, and delivered by a minister of the department of service concerned.

XI. *Jurisdiction of Parliament as a Court of Justice.*—i. For the trial of a peer, indicted for treason or felony, or for misprision of either, the lords spiritual and temporal sit as the court of the lord high steward of England, an office which is in general created *pro hâc vice* by a commission under the great seal. But, if the trial should occur during the sitting of parliament, it is said to be before the court 'of our lady the queen in parliament;' in which case the high steward is only, as it were, pro tempore speaker of the house, and has a vote with the other peers; whereas, in his own courts, held in the recess of parliament, he is judge of the court, and, like any other judge, sole arbiter on the question of law.

ii. The House of Lords has also a twofold jurisdiction: 1. in criminal cases, 2. in civil cases.—1. The first is for the trial of high crimes and misdemeanours by the method of parliamentary impeachment by the House of Commons. [IMPEACHMENT.] The proceeding on a bill of attainder, or of pains and penalties, is, in fact, a legislative act, and not a judicial one. [ATTAINDER; PAINS AND PENALTIES, BILL OF.] 2. The jurisdiction of the House of Lords, in civil cases, is divided by Lord Hale into their jurisdiction in the first instance, and in the second instance as a court of appeal; but the former, which consisted in special powers of interference, occasionally exercised for particular purposes, is now obsolete. In the last instance, the House of Lords is the supreme court of judicature in the kingdom. Appeal lies to it, by writ of error, from the subordinate common law court of appeal of the Exchequer Chamber; and appeal from the High Court of Chancery also, not only in order to obtain the reversal of a decree, but also on any interlocutory matter. On writs of error, the House of Lords pronounces the judgment; on appeals, it gives directions to the court below to rectify its own decree.

XII. *Privilege of Parliament*, in the ordinary sense of the words, denotes the privileges of individual members of either house, enjoyed by virtue of their seats. These privileges are partly limited by known precedent, or by statute; but they are to a great extent customary, and the houses themselves constitute the only tribunals before which the enquiry whether their privileges have been violated or not can be instituted.

The first privilege is freedom of speech in debates: this claim is sanctioned by the stat. 2 Wm. & Mary 2, which declares the liberties of the people. This privilege does not extend to the publication of what is spoken: if a member publish his speech without the authority of the house, he is liable to the common legal tribunals for its contents. An exception to the privilege also is to be found in the jurisdiction of the house itself; which has the power of committing, expelling, or fining (the latter not exercised since the reign of Elizabeth) a member for a libel or contempt against the dignity of the house.

The next privilege, of freedom from arrest in civil suits, is probably as old as parliament itself. Privilege of parliament was formerly supposed to exempt peers and members of the House of Commons from civil actions as well as arrests; but this was finally abolished by 10 Geo. III. This privilege extends to Scotch and Irish peers, though not having seats in parliament. The exemption does not extend to criminal cases or breaches of the peace; or to attachments in case of contempt by the superior court. And, by a peculiar process enacted by 10 Geo. III., but now regulated by 12 and 13 Vict. c. 106, a member of parliament may be made a bankrupt. Unless the bankruptcy is superseded within twelve months from its being issued, he vacates his seat. The liberation of parties improperly arrested is effected either by the authority of the houses themselves, or, when parliament is not sitting, or (in the case of peers) when it is dissolved, on motion in the courts from which the process issued. The duration of the privilege, in the case of members of the lower house, is not exactly defined. It is the general opinion that it extends forty days after every prorogation, and forty before the next appointed meeting. Members of parliament are not liable to be called on to serve as jurors during sitting or adjournment.

The general or 'ancient and just' privileges of the houses are, as has been said, undefined. 'The law of parliament,' says Hallam, 'as determined by regular custom, is incorporated into our constitution; but not so as to warrant an indefinite uncontrollable assumption of power in any case, least of all in judicial proceedings, where the form and essence of justice are inseparable from each other.' There

have been several instances in which questions relating to parliamentary privilege have come before the ordinary courts, in actions for libels contained in papers published by order of parliament (now provided for by stat. 3 and 4 Vict. c. 9), or for arrests made under the Speaker's warrant, &c. Questions of this nature are at present in an unsettled and unsatisfactory position.

Besides the general privilege of parliament, we may here briefly notice the privileges claimed by the two houses, or by members of them, with respect to the conduct of their legislative proceedings.

Two privileges peculiar to the House of Lords are: 1. That possessed by every peer of giving his vote by proxy (see antè, *Rules of Business in the two Houses*); 2. That which he possesses of entering on the journals of the house his dissent from a vote of the house, together with his reasons for it, which is styled his protest. The first protest, with reasons annexed, is said by Lord Clarendon to have been made in 1641.

Of the peculiar privileges of the House of Commons, the most important is that of originating all money bills; and this, in principle, is a very ancient part of the constitution. But it was not before 1690 that it was fully established that the lords could not alter, any more than originate, any rate or tax granted by the commons. This privilege is now understood under the following limitations: In bills of aid and supply, the lords can neither originate them nor make any alterations beyond verbal amendments. In bills which impose pecuniary burdens as a collateral object—such, for example, as bills for turnpike roads and canals, or for the management of the poor—the lords may make amendments, but not such as affect the quantity, disposition, or collection of the rate. No amendments *may be made by* the lords which appear likely, in their consequences, to bring a charge on the people; nor can they insert or alter any pecuniary penalties and forfeitures in a bill.

By a resolution bearing date 1667, and now strictly adhered to, any proposition for taxing the subject must be first examined by a committee of the whole house, and their opinion reported. The effect of this rule is, that subjects on which frequent speaking by the same member and other departures from regular proceedings are desirable, are discussed in a meeting unfettered by some of the special rules of the house.

When a bill of supply has received the concurrence of the lords, it is returned to the commons, and by them presented to the throne.

XIII. *Adjournment.*—An adjournment is a continuance of the session from one day to another. This is done by each house for itself either from day to day, or over a recess, as at Christmas and Easter. In neither house can the Speaker adjourn unless upon motion of the house, except when there is no quorum present, or when he is otherwise empowered to adjourn the house.

XIV. *Prorogation of Parliament.*—A prorogation is the continuance of parliament from one session to another; and is made by the royal authority, either expressed by the lord chancellor in the sovereign's presence, or by writ under the great seal, or by commission. In the proclamation for prorogation, if it is intended that parliament, when next it meets, shall proceed to the despatch of business, notice is given of that purpose; and in cases of urgency the queen is empowered to call together parliament with fourteen days' notice only, even when it has been prorogued to a more distant day.

XV. *Dissolution of Parliament* is effected either, 1. By the sovereign's will, which is the exercise of one of his highest prerogatives: this is usually done by proclamation after parliament has been prorogued. 2. By the demise of the crown; but by 7 & 8 Wm. III. the existing parliament continues six months after that event; assembles immediately, if under prorogation or adjournment; and if there be no parliament at the time, the members of the last parliament are empowered to reassemble themselves. 3. By efflux of time; viz. at the end of every seventh year (if not sooner dissolved by the Septennial Act 1 Geo. I. s. 2 c. 38). The seven years are counted from the day on which parliament was appointed to meet in the writ of summons. (See, as the most useful authority, May's *Law and Practice of Parliament*; see also Hatsell's *Precedents in Parliament*.)

The parliament of France, like those of England and Naples, was in its origin a convocation of the great vassals of the crown, who treated of judicial as well as political matters in their assemblies. St. Louis was the king who first introduced into this body counsellors of inferior rank, chiefly ecclesiastics, as legal assistants; and the earliest registers of the proceedings of the parliament, which afterwards became fixed at Paris, are of the date of 1254. The important step of rendering that court permanent, and fixing its seat in the capital city is generally attributed to Philip the Fair (1304): from that time the great barons gradually discontinued their attendance, and the lawyers occupied the higher places and more important functions of the court. The twelve peers of France, however, remained constant members of the parliament, after the other great vassals had, by disuse, ceased to be considered as members of it (although they, likewise, in process of time, ceased to take part in its judicial business). The parliament of Paris thenceforward remained the chief tribunal of the country until the revolution, with the exception of the short period of its suppression by Louis XV. in 1771; but as the great fiefs of the French monarchy were successively united to the crown, the supreme feudal court of each was invested with the title and attributes of a parliament. These were fixed at Toulouse, Grenoble, Bordeaux, Dijon, Besançon, Rouen, Aix, Pau, Rennes, Metz, Douay, Nancy. The most remarkable prerogative exercised by the parliaments is one of which the origin has

not been satisfactorily accounted for; that of registering the edicts of the sovereign, and thereby giving them the force of law. M. Meyer (*Institutions Judiciaires*, liv. iv. ch. ix.) supposes that it arose from the character of the parliament, as the court of the feudal lord of each province; thus the edict of the king of France was referred to the parliament of Bordeaux, to examine whether it interfered with the special rights and duties of the same sovereign as duke of Guienne, &c. It appears, however, to have been the received doctrine, by the end of the fourteenth century, that this formality of registration was essential to the validity of an edict in every province. Hence the important part which the parliaments, and especially that of Paris, so often enacted in French history, in modifying the otherwise absolute power of the monarchs. [BED OF JUSTICE.] It was usual for the parliament of Paris, and undoubtedly legal, although not customary, for the other parliaments, to convey remonstrances to the king on the subject of his edicts. But Louis XIV. ordained that these remonstrances should always be presented after they had testified their obedience by registering them. The parliaments had also a power of a legislative character, that of pronouncing *arrêts de réglement*, by which they gave authoritative decisions on legal questions, binding not only on present but in future cases. The counsellors of parliament were, by a law of Louis XI., immovable except in case of legal forfeiture; but the place of counsellors and presidents soon became purchasable, and afterwards transmissible by hereditary descent. Hence, in part, the powerful esprit de corps which distinguished those bodies. As a high court of appeal, the parliament of Paris was divided into five chambers: one termed the great chamber, three *des enquêtes*, one *des requêtes*. Besides these, the *chambre de la tournelle*, in which criminal cases were tried, was a fluctuating court, in which members of all the regular chambers sat in turn.

Parlour (Fr. parler, *to speak*). This word signified originally the little room in which nuns and monks gave interviews to their visitors; or in which the novices converse together at the hours of recreation.

Parmenianists. In Ecclesiastical History, a name given to the DONATISTS, from Parmenianus, bishop of Carthage, one of their chief leaders, and an antagonist of Augustine.

Parmentiera. A South American genus of *Crescentiaceæ*, bearing peculiar fleshy cylindrical fruit, whence one of the species, *P. cereifera*, found in Panama, is sometimes called the Candle-tree. The fruits are often four feet long, and somewhat resemble yellow wax candles; they have a peculiar apple-like smell. The fruit of *P. edule* is eaten by the Mexicans.

Parnassus. A mountain in Phocis, sacred to Apollo and the Muses. On its side stood the city of Delphi, near which flowed the Castalian spring.

Parody (Gr. παρῳδία). A species of composition in which the form and expression of grave or serious writings are closely imitated in similar passages of a ridiculous character. Parody is a species of burlesque [BURLESQUE]; but the imitation is more close and exact than in ordinary burlesque composition. The Greek BATRACHOMYOMACHIA, though a very ingenious specimen of the burlesque, is not, in the modern sense of the word, a parody. The French critics have attempted but hardly established a distinction between parody and *travestie*.

Parol (Fr. parole). In Law, word of mouth. Thus, a parol agreement is contrasted with one in writing, parol with written evidence, &c. But the term is also used to include written as well as verbal agreements, and to distinguish both from specialties or deeds. [AGREEMENT; EVIDENCE; SPECIALTY.]

Parole. In Military language, the promise on honour to reappear when called for, given by a prisoner allowed to go at large. Also the pass-word, daily given out by the commanding officer, in field or garrison.

Paronomasia (Gr. from παρά, and ὄνομα, *a name*). In Rhetoric, a figure by which the same word is used in different senses, or words similar in sound are set in opposition to each other; so as to give a kind of antithetical force to the expression.

Paronychia (Gr. παρά, and ὄνυξ, *the nail*). A whitlow; an abscess under or on the side of the nail.

PARONYCHIA. In Botany, the name of an inconspicuous genus of herbs, belonging to the *Illecebraceæ*.

Paronymous (Gr. παρώνυμος). In Grammar, words of similar derivation, or principal words with their derivation; e.g. *equus*, *eques*, *equito*; *man*, *manhood*, *mankind*.

Parophite. A kind of Agalmatolite.

Parotid Gland (Gr. παρωτίς, from οὖς, *the ear*). A large gland situated under the ear, between the zygomatic process of the temporal bone and the angle of the lower jaw. It secretes saliva, which is carried into the mouth by the *Stenonian duct*.

Parotitis. Inflammation of the parotid gland. [MUMPS.]

Paroxysm (Gr. παροξυσμός, from ὀξύς, *sharp*). In Medicine, the periodical exacerbation of a disease.

Parr. This name is applied in most parts of England and Scotland to the young of the salmon (*Salmo salar*, Linn.) up to near the end of their second year, when they lose their dark lateral bars by the superaddition of a silvery pigment, and congregate together for their seaward migration. From the circumstance of the milt being developed at this immature period, a precocious condition by no means uncommon in the cold-blooded tribes, the parr has been regarded by some ichthyologists as a distinct species, and was described as such by Willughby and Ray, under the name of *Salmo salmulus*. [SALMON.]

Parrel (Port. aparelho). In Naval language, the collar of greased rope, or the trucks, by which a yard is confined to the mast while it slides up and down it.

Parricide (Lat. parricidium, from pater, *a father*, and cædo, *I kill*). Properly, the murder or murderer of a father. But the term is also extended to the murder of any near relative, as a husband, wife, mother, &c.; and by the jurisprudence of some countries even to that of distinguished or sacred persons. The Athenians had no law against parricides, from an opinion that human atrocity could never reach to the guilt of parricide. This was also originally the case at Rome; but at a later period parricide was punished by the Roman law with greater severity than any other kind of homicide. The delinquent, after being scourged, was placed in a leathern sack, with a dog, a cock, a viper, and an ape, and so cast into the Tiber. The English law treats this crime as simple murder.

Parrot. [Psittacus.]

Parrot Coal. [Cannel Coal.]

Parsee. The name given by English writers to the Persian refugees, driven from their country by the persecutions of the Mussulmans. They now inhabit various parts of India. Their principal emigration to Surat, and the neighbouring coast, is supposed to have taken place about the end of the eighth century. (Max Müller's *Lectures on the Science of Language*, 192.) The sacred fire, the emblem of their religion [Guebres], called *behrem*, is believed by them to have been brought by the first emigrants from Persia, and, after many changes of place, is now preserved at Odisari and Nausari, near Surat, and at Bombay. In this latter city, under the protection of the British government, they have grown into a colony of considerable numbers and of great opulence. They have become particularly distinguished in the art of ship-building, and the dockyard of Bombay is now almost exclusively in their hands. Their character is variously estimated by different observers; but all agree in attributing to them industry and economy, and attachment to their religion, and to those of the higher class strong sentiments of honour and honesty. Their number is said to equal 700,000; and at Bombay, according to late calculations, at least 20,000. [Dualism; Hylism.]

Parsing. The art of resolving a sentence into its grammatical elements or parts.

Parsley (Fr. persil, Gr. πετροσέλινον). A well-known garden herb used for flavouring, the produce of *Petroselinum sativum*, an Umbelliferous plant found in the South of Europe. The wild form has plane much-divided leaves, and is sometimes mistaken for the Fool's Parsley (*Æthusa Cynapium*), a poisonous weed of garden ground; but this cannot happen if the crispy-leaved varieties known as curled parsley are used.

Parsnip (Lat. pastinaca, Dutch pasternak: the latter half of the English name being the nip of Turnip, a tap root: Wedgwood). The name of one of our common esculent roots, furnished by *Pastinaca sativa*, an Umbelliferous plant, which, like the Carrot, Cabbage, and many others, has been ameliorated by cultivation and selection, until it has become changed from a useless weed into a most useful and nutritious article of vegetable food. Parsnip roots have been in use from a very early period, and at the present day are in great request during Lent as an accompaniment to salt fish. They have a somewhat peculiar aromatic flavour, but are generally relished. They are saccharine and nutritious. What is called Cow Parsnip, is the *Heracleum sphondylium*.

Parson (Lat. persona ecclesiæ). In Law, one that has full possession of all the rights of a parochial church. His title is derived from the Latin persona, because in his person the church itself which he occupies is represented; and he is a corporation sole. A parson, or rector, has the freehold of the parsonage house, the glebe, the tithes, and other dues, during his life. Four requisites are necessary to constitute a parson: Holy Orders, Presentation, Institution, and Induction [which see].

Part (Lat. pars). In Music, a single line of the score or partition, being one of the various instruments or voices which constitute the elements of the composition. [Partition.]

Part Owners. In Law, part owners are distinguished from partners, as holding property (chiefly ships) in individual shares without liability for each other's debts or engagements.

Parterre (Fr.). In Gardening, a system of beds of different shapes and sizes in which flowers are cultivated, with intervening spaces of gravel or turf for walking on. The form of the beds may vary according to the taste of the designer; but their breadth should never be greater than will admit of the spectator who wishes to gather flowers, or the gardener who is to cultivate them, reaching the middle. Where the object is chiefly to produce a display of flowers, the beds should be of simple shapes, with few acute angles, as these can never be completely covered with plants; but where the object is to display a curious figure, to be seen from a point considerably above the level of the parterre, the beds may be formed of arabesque shapes, or like the figures used in embroidery and lace-work. Figures of this kind are generally planted with dwarf box, kept low by clipping, with only here and there a flowering plant, or a small shrub, placed in the broadest parts of the beds or scroll-work. Such parterres were in use during the time of the Romans, as appears by the description of Pliny's garden by himself, in which the letters composing his name were of box, kept regularly clipped, a practice not uncommon in Rome and its neighbourhood at the present day. Embroidered parterres, however, were brought to the highest degree of perfection in the time of Louis XIV., when the arabesque style of ornament was introduced into everything. The flowers and flowering shrubs in

culture in those days were comparatively few; and hence the leading features of the parterre were beds of turf, always an object of luxury, and requiring in the climate of France to be kept up at considerable expense of watering and scroll-work of box. This sort of parterre was imitated in England; but smooth green turf not being here an object of luxury, beds of flowers became more frequently substituted in its stead; and as the number of foreign flowers introduced increased, the number of turf beds and scroll-work diminished, till, at the present time, the latter is rarely to be met with. In this manner has gradually arisen the modern English flower garden, which consists of small beds, scattered over a surface of smooth turf, so as to combine into groups, which are planted with flowers, or low flowering shrubs; sometimes in masses of only one kind in a bed, and at other times of several kinds mixed together.

Parthenogenesis (Gr. παρθένος, *a maiden*; γίγνομαι, *to be born*). In Physiology, the procreation of offspring by a plant or animal independently of the immediate stimulus of the male principle. The impregnated seed of a plant produces a *phyton* of the proper species, usually in the form of a leaf, with a stem and root; from this a succession of *phytons* may be developed by gemmation, most of them having the form of leaves; but, in the higher species of plants, some may take the form of *petals*; others of *stamens*, developing the male principle, or *pollen*; others of *pistils*, forming the female principle, or *seed*. By the union of these two principles the seed is impregnated, and may germinate; but the series of individuals successively developed from the first individual from the seed are procreated by *parthenogenesis*. The different individuals being organically connected, according to a definite pattern for each species, form a compound whole, which is commonly regarded as the individual *tree* or *shrub*.

In the compound Polypes the first individual polype from the impregnated ovum developes a succession of individuals, by gemmation, most of which may resemble the first-formed polype; but others are modified so as to reproduce the male principle, or the ova: these generative polypes are also, sometimes, as in *Coryne* and *Campanularia*, set free. For other instances of this alternating kind of generation, see Steenstrup *On Alternate Generation*, and Owen *On Parthenogenesis*.

Parthenon (Παρθενών). The magnificent temple of Athena [MINERVA] in the Acropolis of Athens, so called in honour of the virginity of that goddess (from παρθένος, *a virgin*). It was a peripteral octostyle of the Doric order, with 17 columns on the sides, each 6 feet 2 inches in diameter at the base, and 34 feet in height, elevated on three steps. Its height, from the base of the pediments, was 65 feet, and the dimensions of the area 233 feet by 102. The eastern pediment was adorned with two groups of statues, one of which represented the birth of Athena, the other her contest with Poseidon (Neptune) for the government of Athens. On the metopes was sculptured the battle of the Centaurs with the Lapithæ; and the frieze contained a representation of the Panathenaic festivals. Ictinus, Callicrates, and Carpion were the architects of this temple; Phidias was the artist; and its entire cost has been estimated at 1,500,000*l.* sterling. Of this building eight columns of the eastern front and several of the lateral colonnades are still standing. Of the frontispiece, which represented the contest of Poseidon and Athena, nothing remains but the head of a sea-horse and the figures of two women without-heads. The combat of the Centaurs and the Lapithæ is in better preservation; but of the statues with which this temple was enriched, that of Hadrian alone remains. The Parthenon, however, dilapidated as it is, still retains an air of inexpressible grandeur and sublimity; and it forms at once the highest point and the centre of the Acropolis. It is hardly necessary to inform the reader that the chief portion of the sculpture of the Parthenon is now placed in the British Museum, where it forms, with some additions, the collection of the Elgin Marbles. [ELGIN MARBLES.] (Beulé, *L'Acropole d'Athènes*; *Edinburgh Review*, No. 223, p. 35.)

Parthenope (Gr.). One of the planets belonging to the group between Mars and Jupiter. [ASTEROID.]

Partial Differentiation. [DIFFERENTIATION.]

Partial Fractions. In Algebra, fractions whose algebraical sum is equal to a given fraction. The resolution of a fraction $\frac{f(x)}{F(x)}$, where the numerator and denominator are rational and integral functions which have no common divisor, into partial fractions, is a problem of great importance in the integral calculus. Let a, b, c, &c. . . . be the unequal roots, real or imaginary, of $F(x)=o$, so that

$$F(x)=(x-a)^{\alpha}(x-b)^{\beta}(x-c)^{\gamma}\ldots\ldots$$

where α, β, γ denote respectively the numbers of times the roots a, b, c . . . are repeated. The above fraction may then be expressed in the form—

$$\frac{f(x)}{F(x)}=\phi(x)+\frac{A_{\alpha}}{(x-a)^{\alpha}}+\frac{A_{\alpha-1}}{(x-a)^{\alpha-1}}$$
$$+\ldots+\frac{A_1}{(x-a)}+\frac{B}{(x-b)^{\beta}}+\frac{B_{\beta-1}}{(x-b)^{\beta-1}}$$
$$\frac{B_1}{(x-}+\&c.$$

where $\phi(x)$ is a rational and integral function obtained by actually dividing the numerator by the denominator, when the degree of the former is not less than that of the latter, and

$$A_{\alpha}, A_{\alpha-1}\ \ldots\ B_{\beta}, B_{\beta-1}\ \&c.\ \ldots$$

are constants. It can be readily shown that this decomposition is *unique*, so that the values of the several constant numerators may be determined in any order and by the most

suitable method. It will suffice, therefore, to indicate the most simple way of determining the values of the coefficients A. By multiplying the whole of the last equation by $(x-a)^a$, it assumes the form

$$\psi(x) = \phi(x)(x-a)^a + A_a + A_{a-1}(x-a)$$

$$\therefore \; . \; . \; . \; . \; . \; . + A_1(x-a)^{a-1} + \frac{f_1(x)}{F_1(x)}(x-a)^a,$$

where $\psi(x) = \frac{f(x)}{F(x)}(x-a)^a$, and $\frac{f_1(x)}{F_1(x)}$ denotes the sum of the partial fractions arising from the other roots $b, c,$ &c. . .; now on differentiating this equation $(a-1)$ times successively, and putting $x=a$ in the a results, we have at once,

$$A_a = \psi(a), A_{a-1} = \psi'(a) \, . \, . \, A_{a-2} = \frac{\psi''(a)}{1.2} \text{ \&c. . .}$$

and finally,

$$A_1 = \frac{\psi^{(a-1)}(a)}{1.2 \, . \, . \, . \, (a-1)}.$$

If a i maginary root of the form $h+k\sqrt{-1}$, then amongst the other roots will be found its conjugate, say b, of the form $h-k\sqrt{-1}$, and the two corresponding partial fractions $\frac{A_1}{(x-a)}+$ will combine to give one of the form $\frac{Lx+M}{(x-h)^2+k^2}$. If the imaginary root a be repeated a times, it and its conjugate will give rise to partial fractions of the form

$$\frac{L_i x + M_i}{[(x-h)^2+k^2]^i}$$

where i has the several values $1, 2 \ldots a$. The coefficients L_i, M_i may be determined either by the above method or by that of indeterminate coefficients.

Participants (Lat. participare, *to share*). A semi-religious order of knighthood, founded by Pope Sixtus V., in 1586, in honour of Our Lady of Loretto. The members of this order were allowed to marry. The order was soon extinguished; and the title of Knights of Loretto is now conferred on some civil servants of the pope.

Participle (Lat. participium). A part of speech which *partakes of* the properties both of a verb and an adjective. It may be described either as a verb without affirmation, or as an adjective with the addition of the notion of time. [GRAMMAR.]

Particle (Lat. particula, *little part*). In Grammar, a general term to express the subordinate or secondary parts of speech—the adverb, the preposition, and the conjunction. But it is more in accordance with grammatical precision to apply this term to those minor words to be met with in all languages which serve to give clearness and precision to a sentence. The term *particle* is also applied by grammarians to those words or enclitics (as they are called, from Gr. ἐν, and κλίνω, *I bend*) which cannot be used separately, but must form part of the preceding word, as the Latin *que* in *virumque*, and the English *ward*, in *backward*.

PARTICLE. In Physics, this word denotes the minutest part into which a body can be mechanically divided. It is in general used synonymously with molecule, corpuscle, atom; but sometimes these terms are distinguished.

Particular Tenant. In Law, the tenant of a prior estate in lands, tenements, or hereditaments less than the fee simple, and upon or following which subsequent estates are limited, as in the common case of a settlement upon one for life followed by remainders to his issue in tail.

Particularists. In Theology, those among the Reformed who have held the doctrine of particular salvation and reprobation. As a party name, it seems to date from the synod of Dort. That branch of the Baptists attached to high Calvinistic opinions is still called the church of the *Particular* Baptists.

Partidas, Las Siete (Span. *the seven parts*). A celebrated ancient Spanish code of laws, drawn up in the reign of Alphonso X. of Castile (about 1260), so called from the number of principal parts into which it is divided. This famous collection did not acquire the obligatory virtue of a code until 1338, when it was sanctioned by Alphonso XI.

Partisan (Fr. pertuisane, from Lat. pertundo, *I thrust through*). A weapon consisting of a blade at the end of a long staff, much used by foot soldiers in the sixteenth century.

Partition (Lat. partitio, *a distributing*). In Architecture, the vertical assemblage of materials which divides one apartment from another. The term is usually, however, employed to denote such divisions as are constructed of vertical pieces of timber, called *quarters*.

PARTITION. In Law, the division into separate parts of property held by two or more persons in undivided parts, as joint tenants, tenants in common, &c. This may be done by mutual agreement, or, in case of disagreement or where persons under disability are interested, by recourse to the Court of Chancery.

PARTITION. In Music, the arrangement of the several parts of a composition on the same page or pages, ranged methodically above and under each other, so that they may be all under the eye of the performer or conductor, and that thus the whole sense of the music may be seen at one glance. It is commonly called a *score*. When a score of a great composition, such as an oratorio, contains all the parts, vocal and instrumental, comprised therein, it is called a full score; but frequently the vocal parts only are so printed, the instrumental parts being compressed into an accompaniment for the pianoforte, and this is then called a vocal or pianoforte score.

Partitions of Numbers. The resolution of integers into parts subject to given conditions. A simple problem in the partition of numbers is the following: In how many ways

can a given number n be resolved into parts not exceeding m in number; or into parts not exceeding m in magnitude? According to Euler's law of reciprocity the solutions of these questions are identical. The writers on the subject are very numerous, and the subject itself, though exceedingly difficult in its higher branches, a very wide and important one, as may be well seen by a reference to Sylvester's exceedingly suggestive *Outlines of Lectures on the Partitions of Numbers*, London 1859.

Partners. On Shipboard, the frames of woodwork round the masts, capstan, pumps, &c., to strengthen the deck and furnish a firmer foundation.

Partnership. A relation established between two or more persons, by an agreement to combine property or labour in furtherance of a common undertaking, and for the acquisition of a common profit. A community of profit between the parties is the true criterion of a partnership; for one partner may stipulate to be free from loss, and this stipulation would be effectual as between himself and his partners, though he would be liable equally with them to the world at large. A dormant partner, i.e. one who in point of fact participates in the profits of a firm, but is not held out as a member of it, will nevertheless be liable for its engagements, because he takes part of that fund which is a security to creditors for payment of their debts. There is no particular form necessary to the constitution of a partnership, nor is it necessary that the contract should be in writing. It may be dissolved at the will of any partner if no period has been fixed for its duration; and even if such a period has been fixed, it may be dissolved by mutual consent of the partners, or by the decree of a court of equity in case of the hopeless state of the partnership business or the confirmed insanity or gross misconduct of one of the partners. So, also, in the absence of an express agreement to the contrary, a partnership is dissolved by the assignment by one partner of his share in the business, or his bankruptcy or death, or, in the case of females, by marriage.

A partnership is by any of the above matters terminated as between the partners themselves; but, to prevent a continuing liability to strangers, public notice of the dissolution is necessary. One partner cannot sue another at law in respect of the partnership account, unless a balance has been struck; the remedy being in equity, which affords a machinery better adapted to the investigation of accounts. As regards the rights of third persons against the partnership, it is a general rule that it will be bound by the engagements of any one partner acting with reference to the joint business, either by his simple contracts on the purchase and sale of goods, or by negotiable instruments circulated on its behalf. By a recent statute (28 & 29 Vict. c. 86) persons are enabled to receive a share in the profits of a business as interest upon a loan or remuneration for services, and in some similar cases, without thereby becoming partners or subject to the liabilities of the person carrying on the business.

Partridge. [PERDIX.]

Partridge Wood. The variegated wood of certain South American and West Indian trees, one of which is supposed to be *Andira inermis*.

Party (Fr. parti, *divided*). In Heraldry, a term used to signify the division of a shield by a line running in the direction of either of these ordinaries, as in party per pale, fess, &c.

PARTY. In Politics, a body of men united under different leaders, for promoting by their joint endeavours the national interest, upon some particular principle in which they are all agreed.

Party Wall. In Architecture, this term is used to designate a wall built upon the joint land of two tenants, or intended to separate two distinct tenements; and in this respect it differs from an external wall, built entirely upon the ground of the same landholder. The regulations established in London, with respect to the thickness of party walls, have been the subject of several statutes, beginning from the time of Charles II.

Parulis (Gr. παρουλίς, from παρά, and οὖλα, *the gums*). A gum-boil.

Parus (Lat.). A genus of Conirostral Passerine birds allied to the crows, characterised by having the conical beak straight and rather slender, with few hairs at its base; nostrils round, and covered by reflected bristly feathers; the hind toe is strong, and armed with a long hooked claw. To this genus belong the native birds commonly called tits or titmice, of which the tomtit (*Parus cæruleus*, Ray) is the best known species. The great tit (*Parus major*), the marsh tit (*Parus palustris*), the cole tit (*Parus ater*), and the crested tit (*Parus cristatus*), have the bill longer and more pointed; the last-named species is rare in this country. They are active little birds, continually flitting from spray to spray, and suspending themselves in all kinds of attitudes, rending apart the seeds on which they feed, devouring insects, and not even sparing small birds, when they happen to find them sick and are able to destroy them. They store up provisions of grain, build their nests in the holes of trees, and produce more eggs than is usual among the Passerine birds.

Pascal's Theorem. In Conic Sections, this theorem may be thus enunciated. The intersections of the three pairs of opposite sides of any hexagon inscribed in a conic lie in a right line. The theorem follows at once from the anharmonic properties of a conic; it may also be proved, after establishing it in the case of a circle, by the method of projections. It also gives rise to important corollaries when two or more of the corners of the hexagon are conceived to coincide. The right line in which the three intersection points lie is called a *Pascal line*. Six points on a conic being joined in all possible ways give rise to sixty different inscribed hexagons, to which correspond sixty

Pascal lines. Steiner in Gergonne's *Annales*, Plücker in Crelle's *Journal*, and Kirkman and Cayley in the *Cam. and Dub. Math. Journal*, have investigated the properties of these lines: a résumé of their investigations will be found in Salmon's *Conic Sections*.

Pascal's theorem is to be found in the discoverer's *Essai sur les Coniques*. He is said to have founded the whole theory of conic sections upon it. The reciprocal theorem was discovered by Brianchon.

Paschal Cycle. The name given to the cycle which serves to ascertain when Easter occurs. It is formed by multiplying by each other the cycle of the sun, which consists of twenty-eight, and the cycle of the moon, which consists of nineteen, years. [PASSOVER.]

Paschal Flower or **Pasque Flower.** The *Anemone Pulsatilla*; so called from its flowering about Easter.

Pasha. A title of honour, given in the origin of the Turkish empire to the ministers and chief assistants of the sultan, whether military or learned. (Von Hammer's *History of the Turkish Empire*, vol. i. p. 137.) In process of time the title was bestowed particularly on the governors of provinces, styled *pashaliks*. The distinction of rank between the two classes of pashas consists in the number of horse-tails which are carried before them as standards, the higher having three and the lower two. There were until recently twenty-five pashaliks, subdivided into sangiacates, besides various independent jurisdictions scattered over the empire.

Pasigraphy (Gr. πᾶς, *all*, and γράφω, *I write*). The imaginary universal language to be spoken and written by all nations, the invention of which has exercised the ingenuity of so many learned men, has been denoted by this word. Leibnitz seems to have been one of the first who conceived this to be possible. Many writers in Germany (where the name was invented) have followed him in the endeavour to devise schemes for this fanciful object. In England, Bishop Wilkins, in the reign of Charles II., invented a scheme for a universal language, grammar, and character. (Max Müller, *Lectures on Language*, 2nd series, p. 47 &c.)

Pasiphaë. [MINOTAUR.]

Pasquinade (Ital. pasquinata). A satirical writing directed against one or more individuals. A mutilated ancient statue of a gladiator dug up at Rome about 300 years ago, which now lies near the Capitol, was popularly termed, by the Romans, 'Pasquino,' from the name, it is said, of a barber of eccentric and well-known character, opposite to whose house it was originally set up. This statue, and another, called by the populace Marforio, in the same neighbourhood, were used for the purpose of bearing satirical placards, often reflecting on the court and church of Rome, which were affixed to them at night, not unfrequently in the form of a dialogue between the two statues. So annoying did Pasquin often become to the government, that on one occasion a serious design was entertained of throwing him into the river; but the ministers of the then reigning pontiff are said to have dissuaded him from it, representing that if this were done, 'the frogs in the Tiber would croak louder than ever Pasquin had spoken.' He has, however, lost his public spirit, and rarely or never ventures to attack the powers that be. But his statue is still the occasional receptacle of jocose comments on private matters. Matthews (*Diary of an Invalid*) mentions an instance which occurred during his stay at Rome. A man of the name of Cæsar (common among the townsfolk there) had married a girl of the name of Roma. Pasquin was placarded with 'Cave, Cæsar, ne tua Roma respublica fiat.' The man replied by Marforio, 'Cæsar imperat.' To which the retort was, 'Ergo coronabitur.' Hence Pasquinata and Pasquilles became, in Italy, conventional words to signify writings of that description, and have been naturalised in other languages. In French and German they have been used in the legal vocabulary in the sense of libel.

Pass. In a Military sense, this word signifies a straight or narrow defile; also, a written permission to a soldier to go on leave.

Passage (Fr.). In Architecture, the part of a building allotted for giving access to the different apartments.

PASSAGE. In Music, a short portion of any composition.

Passage, Birds of. [MIGRATION.]

Passant (Fr.). In Heraldry, a term used to describe a beast when represented in a walking position. Passant guardant, walking with the full face turned towards the spectator.

Passepartout (Fr.). In Engraving, a plate or piece of wood, whose centre part is entirely cut out; round the interior edge of the outer part a border or ornamental design is engraved, and hence it serves as a frame to whatever may be placed in the centre.

The term is also used for a master key to open several locks.

Passerines (Lat. passer, *a sparrow*). The name given by Linnæus and Cuvier to the typical order of birds, including those which neither manifest the violence of the birds of prey, nor have the fixed regimen of the terrestrial birds, but which feed on insects, fruit, or grain, according to the slenderness or strength of their beak; some, with sharp and toothed mandibles, feeding on small birds. All the Passerines have short and slender legs, with three toes before and one behind; the two external toes being united by a very short membrane. They form the most extensive and varied order of birds, and are the least readily recognisable by distinctive characters common to the whole group. Their feet, being more especially adapted to the delicate labours of nidification, have neither the webbed structure of those of the *swimmers*, nor the robust strength or destructive talons which characterise the *bird of rapine*, nor the extended toes which enable the *wader* to walk safely over

marshy soils, and tread lightly on the floating leaves of aquatic plants; but the toes are slender, flexible, and moderately elongated with long, pointed, and slightly curved claws.

The Passerines in general have the females smaller and less brilliant in their plumage than the males; they always live in pairs, build in trees, and display the greatest art in the construction of their nests. The young are excluded in a blind and naked state, and wholly depend for subsistence, during a certain period, on parental care. The brain arrives in this order at its greatest proportional size; the organ of voice here attains its utmost complexity; and all the characteristics of the bird, as power of flight, melody of voice, and beauty of plumage, are enjoyed in the highest perfection by one or other of the groups of this extensive and varied order.

The beak of the Passerines varies in form according to the nature of its food, which may be small or young birds, carrion, insects, fruit, seeds, vegetable juices, or of a mixed kind. The modifications of the rostrum have therefore afforded convenient characters for the tribes or subdivisions of the order, which are termed, 1. Dentirostres; 2. Conirostres; 3. Tenuirostres; 4. Fissirostres. The order is also termed Insessores.

Passiflora (Lat. Flos passionis). The typical genus of *Passifloraceæ*, comprising numerous species, mostly of climbing habit, and many of them of great beauty. One of the most curious parts of their structure is the corona, a circle or coloured thread-like process surrounding the stigma. Several of the species bear edible fruits, known under the names of Granadilla, Water Lemon, Sweet Calabash, &c. The ornamental species are amongst the finest climbers for hothouse or greenhouse cultivation.

Passifloraceæ (Passiflora, or Flos passionis, one of the genera). A natural order of twining calycifloral plants belonging to the Violal alliance of Exogens. They bear very showy flowers, furnished with numerous rays of brilliant colours between the corolla and the stamens. They chiefly inhabit the hotter parts of the world, and bear a fruit not unlike that of the gourd, to which natural order they are related. Independently of the beauty of their flowers, some yield fruits, eaten under the name of Granadilla and Water Lemon; and others have a hard black wood, not unlike ebony.

Passing Notes. In Music, graces wherein two notes are connected by smaller intervening notes.

Passion (Lat. passio). The sufferings of Christ, which He is described as having endured between the Last Supper and the moment of His death. Passion-week is that in the course of which these sufferings took place; namely, that immediately preceding Easter. It was variously called *Hebdomada luctuosa, inofficiosa, pœnosa, indulgentiæ, nigra, sancta, ultima.*

Passion Flower. The popular name for the plants of the genus Passiflora.

Passions. The name popularly given to the different emotions of the mind, as love, anger, &c. Various ingenious speculations have been instituted to ascertain whether the precise situation of the impetus of the passions be in the spiritual or material part of man. Some philosophers, and among these Descartes, consider them wholly seated in the corporeal system. Malebranche regards them as those agitations of the soul which proceed from uncommon influence and motion in the blood and animal spirits. 'Though the passions,' says Burton, in his *Anatomy of Melancholy*, 'dwell between the confines of sense and reason, yet they rather follow sense than reason, because they are drowned in corporeal organs of sense. They are commonly reduced into two inclinations, *irascible* and *concupiscible*. The Thomists subdivide them into eleven, six in the *coveting* and five in the *invading*. Aristotle reduceth all to pleasure and pain, Plato to love and hatred, Vives to good and bad. If good, it is present, and then we absolutely joy and love; or to come, and then we desire and hope for it: if evil, we absolutely hate it; if present, it is sorrow; if to come, fear. . . . All other passions are subordinate unto these four, or six, as some will—love, joy, desire, hatred, sorrow, fear. The rest, as anger, envy, emulation, pride, jealousie, anxiety, miserie, shame, discontent, despair, ambition, avarice, &c. are reducible unto the first' (i. e. the *irascible*). We may merely refer the reader to the works of Hume, Reid, Hartley, Locke, Lord Kames, Bishop Butler, &c. (Maass's *Versuch Über die Leidenschaften*, 2 thle. Halle 1805.)

Passions. In Painting and Sculpture, the representation of the violent emotions of the mind, produced by anger, fear, grief, &c. The expression of the passions is a language without which the painter can never hope for success: it is in this that he has the means of appealing to the sympathy of the spectator. The close observation of nature under similar circumstances is the only mode by which his aim can be accomplished.

Passover or **Pascha.** A festival among the Jews, which derives its name from the incident of the angel *passing over* the houses of the Israelites, and sparing their first-born, when those of the Egyptians were put to death. The name of passover or paschal lamb was likewise given to the *lamb* slain in memory of that deliverance. The festival lasted seven days beginning on the evening of the fourteenth of the month Nisan, and commenced with killing the lamb. The regulations appointed for this festival are detailed in Exod. xii.

Passport. A warrant of protection and authority to travel, granted to persons moving from place to place by the competent officer. The word appears to be derived from the maritime usage of some continental countries, of giving similar authorities from the admiral of a naval station to vessels leaving harbours within his jurisdiction. As passports are not required in our own country, the only species known to

British travellers is that of foreign passports, which, for an Englishman travelling on the continent of Europe, are usually made out by the Foreign Office, or by agents appointed for that purpose at the outports, &c., on payment of a small fee. They are subject to visa or inspection by the proper authorities at the place where the traveller disembarks, and also at other places which he may reach, according to the police regulations of each particular country, and on passing the frontiers of states. France has recently set the example of the abolition of passports, in the case of English travellers; but in that as well as many other continental countries, home passports are necessary for the native traveller. According to the letter of the French law (since 1796), a Frenchman cannot pass the limits of the canton in which he is domiciled without a passport; but in practice it is not required within the extent of the department. Legally speaking, the strict formalities of an internal passport, in France, require the direction of a journey to be specified, and its exact execution attested by the visas and signatures of the police authorities at every place mentioned in it; and these laws are, from their severity, so incapable of complete execution, that it is a common saying, that no man but a rogue is ever entirely en règle with respect to his passport, suspicious characters being usually the most particular in their attention to formalities, for fear of detention. A Frenchman travelling without properly authenticated passport is liable to arrest and detention for a period not exceeding a month. Such, at least, are the legal formalities; but of late years they have been considerably modified in practice in ordinary times.

Paste (Fr. pâte). In Gem Sculpture, a species of glass, used for imitating gems. This art was known to the ancients, and after being lost, was restored, at the end of the fifteenth century, by a Milanese artist. [Glass; Gems, Artificial.]

The term *paste* is also applied to the earthy mixture for pottery and porcelain: also to dough, and to the solution of starch, or wheat flour, made by first mixing it with a proper proportion of cold water, and then adding boiling water under constant stirring so as to form an even solution. Alum is often added to paste, to strengthen it.

Pastel (Lat. pastillus). In Painting, a crayon formed with any colour and gum water, for painting on paper or parchment. The great defect of this mode of painting is its want of durability. Pastels must necessarily be protected by glass. The Picture Gallery at Dresden contains a remarkable collection of this class of drawings or paintings. [Crayon.]

Pastern (Low Lat. pastorium, *a shackle for horses while pasturing*; hence the joint on which the shackle was fastened: Wedgwood). The part of the horse's foot under the fetlock to the heel.

Pasticcio (Ital.). In Painting, a picture painted by a master in a style dissimilar to that in which he generally painted, and in imitation of some other master. David Teniers could, for instance, imitate, with surprising exactness, the styles of many of the first masters of Italy and Flanders. The same may be affirmed of Luca Giordano and several other painters.

Pastil (Lat. pastillus). In Pharmacy, a kind of lozenge. A compound of charcoal with odoriferous substances, which diffuses an agreeable perfume during its slow combustion.

Pastinaca (Lat. *a parsnip*). The botanical name of the Parsnip.

Paston Letters, The. A curious collection, published as original letters by various persons of rank and consequence, four volumes, in 1787 and 1789, by Mr., afterwards Sir John, Fenn, a Norfolk gentleman; a fifth, in 1823, by his literary executor, Mr. Serjeant Frere. They purport to be letters and other documents, collected by, and for the most part written to, members of the Paston family, in Norfolk, during the period from Henry VI. to Henry VII. inclusive; and have been largely used by historical and antiquarian writers for the information which they convey respecting the language and manners of the age.

The authenticity of these letters has been disputed, on grounds stated by Mr. Merivale in the *Fortnightly Review* for Sept. 1, 1865: in particular, that the originals had never been discovered; those of the first four volumes, alleged to have been deposited in the library of George III., never having been found in that repository or elsewhere. But documents stated to be the originals of the fifth volume (which had been equally unaccounted for) have since been presented by the son of its editor, Serjeant Frere, to the Antiquarian Society, where they are now open to inspection.

Pastoral. [Eclogue; Bucolic; Idyll.]

Pastoureaux (Old Fr. *shepherds*). Insurgent peasants who took up arms in France during the absence of King Louis IX. on his crusade. They were led by a Cistercian monk, who took the name of 'Jacob, Master of Hungary,' and seduced them to follow him in his fanatical extravagance. They committed various excesses, from the frontier of Flanders, on which they at first assembled, to Bourges, where their leader was killed in a tumult, and his horde dispersed. Seventy years afterwards a similar insurrection of people calling themselves Pastoureaux broke out under the same pretence of a crusade, and was distinguished by a grand massacre of the Jews. (Hallam, *Middle Ages*, ch. ix. part i.)

Pasture (Lat. pastura, *a feeding ground*). Land under grass and herbage, which is eaten on the spot by horses, cattle, &c. *Hill pasture* is a term applied to hilly and mountainous lands, which are kept perpetually under their natural grasses and herbage, while artificial pastures are produced by sowing on lands which are occasionally subjected to the plough. In all artificial pastures the principal grass is

rye grass, and the principal herbage plant the white clover. Perpetual pastures are such as are never subjected to the plough, and never receive any other manure than what is left on them by the pasturing animals; but artificial pastures are occasionally mown, and sometimes receive a top-dressing of dung, or some mixture of dung and earth, lime, &c.

Patavinity. A term in use among critics to denote a provincial idiom in speech; so named after that of Livy the historian, from his being born at Patavium (Padua), a provincial town of the Roman empire. Wherein the alleged defect of Livy's writings consists, has never been distinctly pointed out by any critic, ancient or modern.

Patchouly. A well-known perfume obtained from *Pogostemon Patchouly*, the Pacha-pat of the Hindus, a subshrubby labiate plant from Sylhet and Malacca. Patchouly is highly popular in India, where it is one of the commonest perfumes found in the bazaars.

Pate. In Fortification, a kind of platform encompassed with a parapet, and having nothing to flank it.

Patée or **Patonce** (Fr.). In Heraldry, a sort of cross, small at the centre and widening towards the ends, which are very broad.

Patella (Lat. *a small plate*). The small, flat, and somewhat heart-shaped bone, which is placed at the fore part of the knee joint, and commonly called the *kneepan*.

Patelloids. The name of a family of Cyclobranchiate Gastropods, having the limpet (*Patella*) as the type.

Paten (Lat. patina). In Ecclesiastical usage, the stand or saucer on which the chalice rests. It was frequently highly ornamented by artists in the fifteenth and sixteenth centuries. In the administration of the Eucharist in England, the paten is the vessel on which the bread is placed.

Patent (Lat. patere, *to be open*). In Political Economy, an act of the executive by which some sole privilege is conferred on an individual, on a partnership, or on a company. The form of a patent is that of an advertisement to the general public, or to all men. Patents are granted by which political privileges are conferred, as those which constitute a peer; or executive, as those by which a bishop, a judge, or a minister is appointed, or by which a corporation is entitled to possess a legal existence, and exercise special powers, as the instruments by which an academical college or a society is created; or, lastly, by which the privilege of sole sale is vested in a corporation and its successors, or in an individual, his assignees, administrators, and executors, for (in general) a fixed and determinate period of time. In the present article we shall busy ourselves chiefly with the last of these senses, the most significant and familiar.

From very early times, the crown exercised, in a capricious and arbitrary way, that part of the prerogative which it was supposed to possess indefeasibly; the right, namely, of conferring special privileges on persons and corporations. We have already adverted, under the head Monopoly, to the leading facts in the history of these royal instruments. At present it is necessary to notice those forms of patent only which are conferred in the interest of the public, or as part of the undoubted right or property of the patentee, or of both the public and the object of the grant.

Under patents conferred in the interest of the public, we may rank the privileges bestowed on universities and other bodies empowered to issue certificates of proficiency to such persons as conform to a course of study, and generally submit to an examination in the subjects in which they are supposed to have attained a sufficient knowledge. It is clear, that, if it were at the discretion of any self-constituted body to grant a diploma in any branch of practical science, the real significance of the distinction would be rapidly lost, and that the public would really suffer by want of any means of discrimination. The office of such bodies is analogous to that of a mint: only those who are experienced can detect degrees of alloy in the precious metals, but anyone can with tolerable distinctness make an estimate of coined money. A certificate of proficiency is an aid towards the discrimination of competency on the part of the person who offers a service, and is thereupon a great gain to the public. It is, however, quite another matter when the government goes beyond this rule of police over the grant of such certificates, and, however much it may be justified in the case of its own servants, enacts that a sole privilege of dealing with the general public should be accorded to the holders of such certificates. It is certain that in practice the public will not agree to any limitation on their discretion in the employment of persons certificated or not, and that in consequence the law will be made only to be evaded. Everyone's experience will inform him how futile are the legislative enactments which pretend to give the privilege of sole practice to such medical practitioners as are certificated by the several constituted medical boards. No sensible person, indeed, would employ the services of incompetent persons; but it may be doubted whether a formal examination secures the public from practical incompetence, and whether also the disposition to exercise private discretion in the choice of persons who may give medical advice is not exaggerated by the very privilege which is conferred on particular individuals. The right of action for malpractice appears to be a perfectly sufficient safeguard against all possible evils of incompetent practice. The same rule applies to the profession of law, the privileges accorded to legal practitioners being on economical principles odious, and in practice nugatory and unnecessary.

Again, a patent may be granted in the first instance for the pecuniary benefit of its object, and its continuance may become a public convenience. Such a patent is the privilege

accorded to the universities and the three queen's printers in the publication of the Bible, because, no suspicion of fraud being possible in these cases, and the patent extending only to the text of the authorised version, the reprint of exact copies is secured to the community, and the chief inconvenience of monopoly, namely a high price, is obviated by the plurality of the patentees and the competition of the publishers. In all likelihood, if the publication of the Bible had been left entirely to private enterprise, it would never have been supplied at so cheap a rate as at present; it is equally probable that the text would have been far less trustworthy.

The word *patent*, however, is commonly used to denote a privilege accorded to an inventor, for the sole use of some process by which an object in demand may be supplied to the public, or some product already familiar to the public may be made more easily and efficiently. In the earliest times in which such patents were granted, the inventors were called projectors, though the extravagant proposals made by such inventors led to the word being used in a contemptuous sense. The ground on which patents are granted is twofold. The interest of the public is supposed to be served by the deferred right which they have in the process or invention (the privilege of sole sale being always limited to a term), and the fact that, in order to secure the right, a full and detailed publication must be given of the process; while the interest of the inventors is served in the presumption that a patent is a stimulus to invention and improvement, and that there is a real right of property in priority of discovery.

Opinion is largely divided as to the efficiency of the patent system in securing these mutual advantages. It is urged in opposition to the view taken of the benefit to the public, that there is far more hindrance put on industrial action by the provisions of patent rights than possible benefit in the future, and that vexatious and mischievous traps are set in the way of independent and bonâ fide adaptation by the existence of an enormous number of obscure rights conferred on those who have appropriated part of the process, the beginning and end of which are matters already of public property; and, further, that the vindication of patent rights involves a great amount of litigation, and, besides the expense implied in the apparatus of law, and the time of juries, entails great charges on manufacturers, and as a consequence great loss to consumers. Again, it is alleged that instead of patent right being a stimulus to invention, it is in fact a stimulus to gambling; that men are diverted from patient and steady industry into dreams of some discovery by which fortunes may be speedily attained; and that there is not and cannot be a more pitiable object than a professed inventor and patentee. It is stated, too, that so far from the interest of inventors being furthered, the person really benefited is some capitalist, who makes a hard bargain for really useful inventions, and appropriates all the profit—that the patent system is a powerful engine for protecting, under the guise of justice to inventors, the present and future gains of mere traders, who contrive by these means to secure a monopoly of supply. And, further, it is alleged that there is no true property in invention; that simultaneous discovery is the rule, independent invention the rare exception; that, in fact, a patent is ordinarily assigned to the mere accident of priority, to the detriment of others who have as effectively found out the power or the process appropriated; and that therefore, on the whole, the disadvantages of the system greatly exceed the benefits. It may be added, that these views are shared at once by many manufacturers and patentees, as well as by economists, and that almost all persons condemn the present system, though they are not agreed as to the remedy.

The case of copyright is very different. There cannot be a simultaneous production by two persons of the same book or work of art, and, therefore, that definite appropriation of a right which cannot be at once possessed by two or more persons in the same object, except by voluntary association, and which constitutes the fundamental characteristic of property, does belong to literary products. It has been doubted, however, whether literary property is in any way benefited by the protection of the law.

The granting of patents is now regulated by the Patent Law Amendment Act 1852, under which an inventor may obtain protection for his invention for six months after filing a provisional specification describing it. He has thus time to consider whether he will take out a patent or not; if he does so, he may obtain a patent for the term of fourteen years on payment of stamp duties to the amount of 25*l.*, but the patent is made determinable at the expiration of three and seven years respectively unless further stamp duties of 50*l.* and 100*l.* are paid: this enables a patentee to abandon an unprofitable invention. A prolongation of the term granted by original letters patent may be obtained upon application to the Judicial Committee of the Privy Council, if it be shown that the expense and labour incurred in perfecting the invention has not been sufficiently remunerated.

Letters patent must be granted for 'new manufactures within this realm which others at the time of making such letters patent and grants shall not use,' i.e. use in *public*.

Letters patent now (contrary to the former law) extend to the whole of the United Kingdom of Great Britain and Ireland, the Channel Islands, and the Isle of Man; and in case the warrant for granting the patent shall so direct, they may be made applicable to the colonies and plantations abroad. Patents and the privileges granted by them are freely assignable from one person to another, and the holder of them may also grant licenses to use the invention, which is usually done on payment of a

royalty according to the amount manufactured of the patented article.

Ever since the reign of Anne it has been a condition in patents, that the inventor should, by an instrument technically called a *specification*, particularly describe the nature of his invention; on failure of which the patent becomes void. An injunction may be obtained, or an action brought, for the infringement of a patent; but it is necessary to show the novelty and utility of the invention, and that it is of something capable of being turned immediately to account in commerce; no patent will be good for a mere philosophical principle neither organised nor capable of being so. It is now held that a new process or method, as well as an article, may be the subject of a patent. The number of patents now annually sealed is said to be about 2,000; of which not above 200 on the average continue beyond the first seven years.

Patents are conferred in most communities, and international rules have been established between some countries for the mutual protection of patentees. The government of Switzerland, however, grants no patents, and that of the United States has hitherto declined to recognise mutual concessions. This cannot, it would appear, be due to any mere desire to appropriate discoveries from other countries, for, of course, in the absence of reciprocity, no protection is given to their own inventions, and, as is well known, the scarcity of labour is a great stimulus to invention in the United States. [Trade Mark.]

Patent Yellow. A pigment obtained by fusing a mixture of oxide and chloride of lead.

Pater Patratus (Lat.). In Roman Antiquities, the chief of the Fecials; specially named for the performance of certain solemn acts, such as declarations of war.

Patera (Lat. *a cup*). In Architecture, the representation of a cup, usually in bas-relief, and employed to decorate friezes, imposts, &c.

Patera. In Roman Antiquities, a large open goblet or cup of gold, silver, marble, or earth, &c., used in offering libations to the gods.

Paterines. In Ecclesiastical History, a name given to the Western Manicheans (Milman's *Latin Christianity*, book ix. ch. viii.), and also to the monkish party, by the married clergy of Milan, in the controversy respecting clerical marriage. (*Ib.* bk. vi. ch. iii.)

Paternoster. The Latin expression for *Our Father*, signifying the Lord's Prayer. [Rosary.]

Pathetic (Gr. παθητικός). In Painting and Sculpture, the expression of the softer or more sorrowful passions. Its tendency is to depress and compose the feelings of the spectator.

Pathetic Nerves. A pair of small nerves, supposed to influence, by certain movements of the eye-ball, the expression of the face. They rise from the *valve of Vieussens* behind the bigeminal bodies, and supply the trochlear muscle of the eye, whence they are also called the *trochlear nerves*. They are reckoned as the *fourth pair of cerebral nerves* in Anthropology.

Pathognomonic (Gr. παθογνωμονικός, *skilled in judging of affections or diseases*). Symptoms which are peculiar to particular diseases, and by which they are recognised, are termed pathognomonic symptoms.

Pathology (Gr. παθολογέω, *to treat of affections or diseases*). Literally, the doctrine of disease. As physiology teaches the nature of the functions of the body in a state of health, so pathology relates to the various derangements of these functions which constitute disease. Its objects, therefore, are to ascertain the various causes which interfere with the normal action of each organ of the body, and to determine the diagnostic and pathognomonic symptoms, which afford the means of discrimination between diseases closely resembling one another. An important branch of pathology is that which treats of diseases of the fluids of the body, and more especially of the disordered states of the blood and of the urine (humoral pathology). This science has made rapid strides during the last half century, owing chiefly to the advance of animal chemistry, and to the application of the microscope in the examination of diseased secretions and excretions.

Pathos (Gr. *suffering*). This word is applied in literary language to the effect produced by any composition calculated to excite all, but chiefly the tender, emotions of the mind. In France, this term is generally used in a somewhat disparaging sense, being applied to that species of composition which indulges in strained and unnatural declamation.

Patina (Lat.). In Numismatics, the fine rust with which coins become covered by lying in peculiar soils, and which, like varnish, is at once preservative and ornamental. It is, says Mr. Pinkerton, a natural varnish, not imitable by any effort of human art; sometimes of delicate blue, like that of a turquoise; sometimes of a bronze brown, equal to that observable in ancient statues of bronze; sometimes of an exquisite green, verging on the azure hue, which last is the most beautiful of all. It is also found of a fine purple, of olive, and of a cream colour, or pale yellow. The Neapolitan patina is of a light green; and, when free from excrescence or blemish, is very beautiful. Sometimes the purple patina gleams through an upper coat of another colour, with as fine effect as a variegated silk or gem. In a few instances a rust of a deeper green is found, and it is sometimes spotted with the red or bronze shade, which gives it the appearance of the East Indian stone called bloodstone. These rusts are all, when the real product of time, as hard as the metal itself, and preserve it much better than any artificial varnish could have done; concealing, at the same time, not the most minute particle of the impression of the coin. Gold admits no rust but iron-mould, when lying in a soil

impregnated with iron. Silver takes many kinds, but chiefly green and red, which yield to vinegar; for in this metal the rust is prejudicial.

The term *patina* is applied also to the coat of dirt and varnish which, through time, covers the surfaces of pictures. The patina or dirty varnish of an old picture often gives the work an adventitious harmony and effect which does not belong to it; and when this extraneous coating has been removed by the cleaner, the picture has lost these borrowed qualities, and is by the inexperienced supposed to have been injured. Hence, skilful cleaners, after cleaning and repairing a picture, cover it afterwards with an artificial patina or glazing, and restore the effect of dirt and age.

Patois. A French word in general use in most European countries, signifying the dialect peculiar to the lower classes.

Patres Conscripti. [CONSCRIPT FATHERS.]

Patriarch (Gr. πατριάρχης, from πατήρ, *father*, and ἄρχω, *I govern*). A title given to the twelve sons of Jacob. (Acts vii. 8.) This title was also assumed in the early ages of the church by the bishops of the principal cities of the empire, as Rome, Constantinople, Antioch, &c. The name was adopted from the practice of the Jews, who, after the dispersion, subjected themselves to the spiritual superintendence of the patriarchs resident at Tiberias and Babylon. [RESCH GLUTHA.] The first mention of a Christian patriarch occurs about 440. They were, for the most part, superior to archbishops or metropolitans, being set over several provinces. This, however, was not always the case. The patriarchs of Ephesus and Cæsarea, for instance, were subject to the bishop of Constantinople, and were only on a par with diocesan prelates.

Patricians (Lat. patres, *fathers*). The original body of Roman citizens, known as the *populus*. As constituting the whole body of the citizens, they held in their hands the government of the state: hence with the growth of the plebs, they assumed, from the strictly hereditary nature of all ancient citizenship, the character of an oligarchy, the suppression of which was the object aimed at in the long struggle of the plebeians against the patricians. The divisions into Ramnenses, Titienses, and Luceres, are variously described by Livy. [LUCERES.] The assembly of the patricians received the name of Comitia Curiata, as the members there voted by *curies*.

Patrick, St., Order of. An Irish order of knighthood, instituted by George III. in 1783, composed of the sovereign, a prince of the blood royal, a grand master, and fifteen knights; the lord-lieutenant of Ireland for the time being is grand master.

Patrinite. A mineralogical synonym for Needle-ore.

Patripassians. [SABELLIANS.]

Patroclus. [PHAETHON; TELEMACHUS.]

Patrole (Fr. patrouille). In Military language, a small party of men, under the charge of a subaltern or a non-commissioned officer, detached from the guard. In garrison towns, a patrole marches at certain hours in the evening and night through the streets, in order to repress disorder, and take into custody soldiers improperly conducting themselves. They are usually accompanied, in continental towns, by an officer of police. [POSTS.]

Patron (Lat. patronus, from pater, *father*). The relation of patron and client, in ancient Rome, has been explained under the head CLIENT. After the extinction of republican sentiments and usages, the term *patron* was still applied to advocates who defended causes for hire. But the right of patronage, analogous to that which had subsisted under the commonwealth, may be said to have existed only in the relation between masters and freedmen, the latter of whom were placed under various obligations to their former owners. In the usage of the Roman Catholic church, a *patron* saint is the peculiar protector of each country, community, profession, &c., or of individuals. The prime minister of the pope is termed the cardinal-patron. (As to the Roman patrons, see *Mém. de l'Acad. des Inscr.* vol. xii.)

Patronage. In Ecclesiastical Law, the right of presenting to a benefice. [PRESENTATION.] The remedy in case of disturbance of a patron in his legal right in the church of England, is by action of quare impedit. In the church of Scotland, the right of presentation to livings in lay patrons was recognised by the old practice of the church, with the exception of the period from 1690 to 1712, during which lay patronage was abolished, and the right of presentation lodged in the heritors (land owners) and members of the kirk session. In 1712, lay patronage was restored, but still under the control of the parishioners, whose *call* (as it was termed) was necessary to ratify the presentation. But the call gradually became a mere nominal ceremony; and disregard to the expressed wishes of the parishioners in one or two instances was the cause of the great secession from the Scottish kirk. [BURGHERS.] In 1834, by an act of Assembly [VETO ACT], the right of the parishioners was fully revived; it being expressly enacted that the disapproval of a majority should invalidate the presentation. This act of the General Assembly, however, was found by the courts of law not to be efficient; but, after the establishment of the Free Church, in 1843, an Act of Parliament (6 & 7 Vict. c. 61), commonly called Lord Aberdeen's Act, was passed, which removed all doubts on the subject, and acknowledged, within certain reasonable limits, the right of the members of the church to have a voice in the nomination of their pastors.

Patronymic (Gr. πατρωνυμικός, from πατήρ, and ὄνομα, *a name*). A name which designates a person in reference to some of his ancestors, either immediate or remote; as Pelides, i.e. Achilles, the son of Peleus; Æacides, i.e. Achilles, the grandson of Æacus. Patronymics were chiefly employed in poetry.

Paulianists. In Ecclesiastical History, a sect professing the Sabellian doctrines of Paulus of Samosata, a bishop of Antioch in the third century, from whom they derived their name. [SABELLIANS.]

Paulicians. A Christian sect whose history is interwoven with that of the Greek church in the ninth and tenth centuries. They appear to have arisen in Armenia, and to have adopted their name from Paulus, one of their leaders, to avoid the imputation of a connection with the Manicheans, which was generally laid to their charge. Their opinions are to be collected only from the allegations of their enemies, who accused them of holding the doctrine of the two principles [DUALISM], and denying that the Old Testament proceeded from the Supreme God. In the East they underwent persecutions for two centuries: a remnant, however, survived in the country of their birth. A colony of Paulicians was transplanted to Bulgaria and Thrace, whence, in the eleventh century, they spread themselves over the West, where they were known under the names of CATHARI, PATERINES, &c., and are vulgarly connected with the Albigenses of the South of France. (Mosheim, vol. ii.; Faber *On the Churches of the Waldenses and Albigenses.*)

Paulite. A variety of Hypersthene, from the island of St. Paul, on the coast of Labrador.

Paullinia (after S. Paulli, Professor of Botany at Copenhagen). A genus of *Sapindaceæ*, some species of which are largely used as a stimulating beverage by the inhabitants of some parts of South America. From the seeds of the Guarana, *P. sorbilis*, the Indians on the Amazon prepare hard cakes called Pao de Guarana (i. e. sticks of Guarana), which form a considerable article of trade, and are carried into all parts of Brazil, where a cooling beverage is prepared from them. The ripe seeds are thoroughly dried, then pounded into a fine powder, made into dough with water, and formed into cylindrical rolls, from five to eight inches long, which become excessively hard when dry. The beverage is prepared by grating about half a tablespoonful of one of the cakes into a glass of sugar-and-water. Its active principle is called *guaranine*, and is said to be identical in its composition with the theine of tea.

P. Cupana also enters into the composition of a national diet-drink; its seeds are mingled with cassava-and-water, and allowed to pass into a state of fermentation bordering on the putrefactive, in which state it is the favourite drink of the Orinoco Indians.

Paulownia. A Japanese tree resembling the *Catalpa*, the only species of which, *P. imperialis*, forms a genus of *Scrophulariaceæ*. It grows into a moderate-sized tree with a spreading head, and has broadly ovate, cordate leaves, and panicles of large purplish-lilac flowers; but as these flowers are borne so early as seldom to escape injury from frost, which also damages the early growth of the shoots, it can hardly be considered as adapted for our climate.

Pauperism. In Political Economy, poor rates are the aid granted out of the rent of land, the incomes of occupiers of land and houses, and the provision of tithes and rent charges, for the maintenance of persons who are unable to work, or unable to find employment; and pauperism is the state in which labourers and others are placed who need and are legally entitled to such assistance. This assistance is almost peculiar to the economical state of the United Kingdom, and till very lately had even a more limited operation, for Scotland was not included in the poor law system till after the disruption of the kirk in 1843, nor Ireland till after the outbreak of the famine in 1846. The history of this remarkable characteristic of the English social system, and the economical effects of the impost upon labour and capital, deserve a brief and exact description.

The writer, in the course of very long and copious enquiry into the economical history of the middle ages, has never but once met with any hint of a rate in aid, appraised and collected for the relief of the poor. This solitary instance is in an account of the manor of Cambridge, then and now held by Merton College, and forming at that time a mesne lordship under the earl of Lancaster. In 1315, the year of the great famine, an agistment was laid on this manor, in common with other Cambridge parishes, for the relief of the distress which then prevailed. It is not easy to discover at this date what were the powers by which such an assessment was made obligatory. It is, however, singular that this sole example should have been discovered, and its occurrence is a strong piece of negative evidence against any formal system of parochial relief. It is well known that the first statute for the relief of the impotent poor was that of 1 Edw. VI. A.D. 1547, and that the first law which gave shape to the modern system of a rate in aid was 43 Eliz. A.D. 1601.

The opinion expressed by the late Mr. M'Culloch, to the effect that the absence of any system of parochial relief was due to the fact that the mass of the community were in a state of slavery, and that by the conditions of slavery the master was bound to maintain his labourers, is not only a false estimate of the state of society for three hundred years before the statute of Elizabeth, but gives no explanation why the gradual extinction of feudal servitude did not bring about a regular system of poor relief, not only in France, Spain, and Germany, but in Scotland and Ireland. The fact is, the popular opinion as to the social condition of the greater part of the peasantry in England during the fourteenth and fifteenth centuries is a mass of misconceptions. No slavery in the ancient or modern sense of the word existed in England from the middle of the thirteenth century, the period at which domestic accounts commence; the lord did not maintain his serf; and the only relations which subsisted between the two were those of payment and service on the one hand, the service being menial, or rather agricultural, in compensation

for grants of land, and the right on the other to heriots, where such customs prevailed, and entry in case of failure of issue, or forfeiture on the part of the tenant, consequent upon feudal transgressions. The serf or villein, it is true, was bound to the soil, but so was the free tenant, the view of frankpledge and the obligation of registration in the tything or decenna, or manor, being laid upon all tenants alike, free and villein.

In fact, there were several causes which would have sufficiently obviated the existence or even the possibility of a general system of rating for the relief of the poor. In the first place, everyone possessed land, and sufficient land to maintain in ordinary times, and according to the existing standard, the exigencies of each family. In the next place, there was no wide difference between the middle classes and the poor, the course of life of the peasant and of all except the few who occupied a considerable social position being really almost identical. The labourer sat at his master's table, and generally dined from the same dish. In the next place, the area under the plough, though by no means so effectively cultivated as now, was probably not much less in extent; and as the population did not exceed the average means of subsistence, the general equality of conditions implied general sufficiency of food. But more powerful even than these causes were the effects of the monastic system. We are not, indeed, aware of the number of the monasteries in England, for the researches of Dugdale have by no means exhausted the catalogue; we are still less informed as to the number of monks they sheltered. But we do know that these monks were all bound by vows of celibacy, that their ranks were recruited from the lower classes of society, that they were in many cases industrial communities, and that all lived slenderly, and they must consequently have been a powerful check to the excessive growth of population. Added to this, they were easy landlords, and notoriously charitable as far as their aid to poverty and distress could be afforded. Whatever may have been the vices of the monastic system, and however ripe their institutions were for suppression, there cannot be a moment's doubt that they served some very important economical ends, and that their sudden annihilation must have induced, even if we had no evidence to that effect, serious and distressing social consequences. So far, there cannot be a doubt that the suppression of the monasteries, and the alienation of their lands to non-resident proprietors, who were bound by no tie, religious, moral, or social, to their poorer neighbours, led to such misery as to suggest the necessity of a legal relief for the poor.

The commencement of the modern system of poor law relief is to be found in the 43 Eliz., which contained provisions for the erection of workhouses and the supply of occupation for those who needed it. Before this Act passed, frequent complaints had been made of the enclosure of lands, and the depopulation of towns and houses, in the interest of those who, having acquired or usurped rights over land, abandoned husbandry for sheep farming, as much from deficiency of capital as from motives of personal interest. The statute of Elizabeth was followed sixty years later by that known as 14 Ch. II. c. 12, the origin of the law of parochial settlement, with all its injustice, selfishness, wastefulness, and hardship. For an account of the operation of this and similar laws, the reader is referred to Mr. Coode's report on the law of settlement and removal. (*Parl. Paper*, 1851, No. 675.) The modern system of poor law relief came into operation in 1835; but the parochial system and the law of settlement were virtually abolished in 1865.

The economical consequences of a rate in aid for the relief of the poor have been variously interpreted; some have held that the system is wholly mischievous, others that it is necessary and politic. To all appearance, this diversity of opinion is due to the fact that the disputants have discussed the matter from different points of view. It may be highly proper and even just that no person should be suffered to starve; it may be that the moral and social evils which would result from any harsh treatment even of deserved poverty would be very great; but this will not prove that the system of legal relief to the disabled or impoverished is capable of an economical defence. It would seem that the sanction of a poor law is rather to be sought in the moral and religious instincts of man, than in any sense of strict economical obligations. Of course this applies to its first imposition; its discontinuance after persons have been habituated to the aid, and society has, so to speak, made its calculations on its permanence, would be a social wrong.

It is well known that there is a portion of profits destined to the employment of inferior or common labour, and it would not be impossible to calculate this capital, if we could know what is the aggregate amount of wages earned by those who come within the contingency of poor law relief. This amount of wages, by virtue of the competition of labourers, and by the fact that labour is habitually in excess of remunerative employment, is never more than can be extracted by the needs of those who must subsist at a certain rate in order to work at all, and to bring up their families as inheritors, in the main, of the toil which they have themselves undergone. In order that this sufficiency may be provided, they must not only have enough for their own maintenance and that of their children, but they must have enough also to provide for that part of their life in which, though still in being, they are not able to carry on their labour, or not to carry it on with the same efficiency as before. They must also be able to provide against emergencies and casualties: emergencies, for instance, such as the enforced cessation of labour by want of employment; and casualties, such as sickness or accident.

It is necessary that these various funds should be supplied, not only in order that labour may exist comfortably, but that it may exist at all, and be forthcoming for the cultivation of the soil, and for whatever other common purpose it may be demanded. Now it cannot be doubted that the poor law, by interposing to secure the labourer against the necessity of saving in order to meet these occurrences (some necessary and others fairly to be anticipated), takes away the obligation, and as population has always a tendency to increase up to the margin of subsistence, or, what is in effect the same thing, to the possibility of industrial occupation, depresses the rate of wages by just as much as would be otherwise needed to meet such emergencies. In all probability, too, as the machinery by which this aid is given is comprehensive, and the supervision over expenditure is strict, and the aid is as far as possible reduced to a minimum, actual wages are lower when taken in connection with legal relief, than they would be in its absence. In fine, the system of poor law aid is virtually an insurance upon labour, effected in part at least, and with some economy, on the part of those who would suffer in increased wages and diminished profits if the machinery were not applied at all; and so far from the agency of the poor law being a boon to the labourer, it really keeps down his wages to an average low amount, the difference being the amount expended in meeting the contingencies adverted to.

That this is the effect of the poor law, is, we believe, demonstrable from the fact that the wages of labour, even of the commonest kinds, have greatly increased since the alteration of the poor law, and the abandonment of the allowance system. At present, while the law deals as generously as it ever did with the sick, the infirm, and the aged, certain minor points of discipline omitted, it is penal on the able-bodied labourer. And this appears to be just, if no hindrance is put in the way of the migration of labour, because it will be seen that all aids provided by the law are so many deductions from the fund which supplies wages to the class which may hereafter be applicants for parish relief. Nothing, however, but a selfish determination to get labour at low rates, and to throw the burden of maintaining it in sickness or old age upon others, could have justified the imposition and retention of the law of parochial settlement. This limitation of the labourer to one site, rendered him as completely adscriptus glebæ as the mediæval serf ever was, and made all possible aid to him when necessity overtook him, an inevitable piece of compensative justice. That the law of parochial settlement, and the penal application of the new poor law to able-bodied paupers should coexist, was, at the time of passing the new Act, felt to be a wrong, though the framers of the Act were unable to provide a remedy in the total abolition of the settlement principle, owing, it would appear, entirely to selfish interests.

It may be doubted, indeed, whether the fact that provision is made by a poor rate for the maintenance of labour, does not induce apathy, immobility, and indifference to material improvement among the classes of workmen who are affected by its influences. Reasoning from analogy, we should think so; and to judge from the improvement in the condition of the labouring classes since the new system came into play, we should be confirmed in this inference. It is probable that the greater hardihood and enterprise of the Scotch and Irish peasantry, and their greater readiness to emigrate, are due to the fact that they have not till lately been affected by the exceptional aids of poor law relief. At the same time, we must remember, that whatever may be the abstract criticism on the effects of a poor rate, the interpretation of social facts and habits necessitates a large modification of the conclusions arrived at. There are, we believe, excellent reasons against the establishment of a poor law ab initio; but to overthrow a system which has been in existence for nearly three centuries, and by the force of which the relations of common labour and capital have been continuously arranged, would be a great social wrong, if not a serious political risk. The reform of 1834 was the maximum that could be effected in the principles of poor law relief: it was even harsh in some of its provisions; but the harshness was necessary, for had the ancient system been continued, there seems little doubt that the rates in aid would have finally equalled the rental of lands let to agricultural purposes, as they did in some cases before the change took place. In short, it does not appear likely that the condition of the working classes in England will ever improve so much as to make it possible that the poor rate may be dispensed with, unless some great revolution takes place in their habits, and some great facilities are given them for bettering their condition; events which at present seem so remote, that, however expedient they may be abstractedly, it would be idle to pretend to speculate upon the effect of their occurrence.

The contributions levied for the relief of the poor are the largest in quantity of all the taxes which are collected for local purposes. It remains to say a few words on their incidence. It has been observed that a poor rate is a contribution to wages; that in its absence the rate of wages must rise; and that, therefore, in so far as the rate is paid by the employer of labour, it is a tax only in appearance. It is, however, a real tax, when contributed by such as do not employ the kind of labour which is ordinarily within the contingency of relief, and when the arrangements made for levying the tax lay a larger share of the rate on some employers of labour, to the comparative relief of others. Both these results have occurred under the working of the poor law. All parties contribute to the relief of the poor according to the rateable value of the premises which they occupy, whether they employ labour or not; and the parochial system,

which originally formed the basis of the whole rate levied for the maintenance of the poor of each parish, or, by successive changes, of the greater part of it, made it possible that the sole owners of parishes should be able to throw most, and in many cases the whole, of the relief required by such as laboured within the parish, upon some locality conterminous with it. The landowners of close parishes contrived to effect this result by destroying house accommodation on their estates, or, in case a larger number of labourers were employed than could be housed in the parish, by forbidding the erection of any new cottages. The poor, being cut off from house room in the parish where they worked, crowded into the open parishes, and, being exposed to the vicissitudes of weather in travelling to and from their work, being badly housed, and forced by mutual competition to pay a rent disproportionate to their wages, were rendered more liable to the attacks of disease, and more within the necessity of claiming parochial relief. When this relief was accorded, it was not paid by the parish in which the labourer worked, but by that in which he was housed, and thus the poor rate became a tax unjust in its incidence, capricious in its amount, and increased by a system which rendered the agricultural labourer's calling hazardous and unhealthy. These anomalies and wrongs, in so far as close and open parishes are concerned, were abolished by an Act of Parliament in 1865, by which the amount of the rate was equalised over the whole union, instead of being, as before, determined by the special or adventitious necessities of each parish. This reform is not only a measure of justice, but, by taking away hindrances to the free circulation of labour, is an advantage of the highest value to the labourer himself.

Table I.—The following is the amount which has been collected by rate, and applied to the relief of the poor, since the year 1748 :—

Years	Sums expended on Poor	Years	Sums expended on Poor
Average	£		£
1748–1750	689,971	1848	6,180,764
1775, 1776	1,530,800	1849	5,792,963
1783–1785	2,004,239	1850	5,395,022
1801	4,017,871	1851	4,962,704
1813	6,656,100	1852	4,897,685
1821	6,959,249	1853	4,939,064
1831	6,798,888	1854	5,282,853
1835	5,526,418	1855	5,890,041
1839	4,406,907	1856	6,004,244
1840	4,576,965	1857	5,898,756
1841	4,760,929	1858	5,878,542
1842	4,911,498	1859	5,558,689
1843	5,208,027	1860	5,454,964
1844	4,976,093	1861	5,778,943
1845	5,039,703	1862	6,077,922
1846	4,954,204	1863	6,527,036
1847	5,298,787	1864	6,423,381

Table II.—The following table contains three columns. 1. The amount of the population taken at the census in 1841, 1851, 1861, with the annual estimated rate of increase; 2. The contribution, reckoned according to each member of the population, for the maintenance of the poor; and, 3. The price of wheat per imperial quarter. In the year 1834, the facts of the last year of the old poor law are supplied. (Compiled from *Parliamentary Papers.*)

Years ended at Lady-day	Population estimated according to the Ratios of Increase	Rate per Head of Amount expended in Relief to the Poor on the Estimated Population		Average Price of Wheat per Imperial Quarter	
		s.	*d.*	*s.*	*d.*
1834	14,372,000	8	9½	51	11
1835	14,564,000	7	7	44	2
1836	14,758,000	6	4¾	39	5
1837	14,955,000	5	5	52	6
1838	15,155,000	5	5¼	55	3
1839	15,357,000	5	8¾	69	4
1840	15,562,000	5	10½	68	6
1841	15,911,757	5	11¾	65	3
1842	15,981,000	6	1¾	64	0
1843	16,194,000	6	5¼	54	4
1844	16,410,000	6	0¾	51	5
1845	16,629,000	6	0¾	49	2
1846	16,851,000	5	10½	53	3
1847	17,076,000	6	2½	59	0
1848	17,304,000	7	1¾	64	6
1849	17,534,000	6	7¼	49	1
1850	17,765,000	6	1	42	7
1851	17,927,609	5	6½	39	11
1852	18,205,000	5	4½	39	4
1853	18,402,000	5	4½	42	0
1854	18,617,000	5	8	61	7
1855	18,840,000	6	3	70	0
1856	19,043,000	6	3¾	75	4
1857	19,207,000	6	1¾	65	3
1858	19,361,000	6	0¾	53	10
1859	19,578,000	5	8¼	42	9
1860	19,837,000	5	6	44	9
1861	20,066,224	5	9	55	10
1862	20,228,000	6	0	56	7
1863	20,445,000	[illegible]	4½	52	1

Pause (Gr. παῦσις, *a stopping*). In Music, a character denoting silence in a part for a certain time, according to the sort of pause marked.

Pavan (Lat. pavo, *a peacock*). A slow and stately dance formerly practised in England, but now confined to the Spaniards. It derived its name from the motion of the dancers' dresses, which was compared to that of the peacock's tail.

Pavement (Lat. pavimentum). In Architecture, a causeway or floor laid with stone, brick, or other material for greater convenience of walking. [ROADS.]

Pavia (after Pierre Paw, Professor of Botany at Leyden). A genus or subgenus of Sapindaceous deciduous trees, distinguished

from the Horse Chestnut (*Æsculus*), to which they are closely related, and which they much resemble by their smooth not prickly capsules. They are chiefly North American, and are frequently met with in shrubberies and pleasure grounds, the trees being of moderate size, and of an ornamental character.

Pavise (Fr. pavois). A large shield, used in the warfare of the middle ages to cover assailants advancing to the walls of a fortress.

Payo (Lat. *a pea-fowl*). The name given by Linnæus to the genus of Gallinaceous birds, of which the splendid Indian peacock (*Pavo indicus*, Linn.) is the type. They are characterised by a crest of peculiar form, and by the tail coverts of the male extending far beyond the quills, and being capable of erection into a broad and gorgeous disc. The shining lax and silky barbs of these feathers, and the eye-like spots which decorate their extremities, are known to everyone. The Indian pea-fowl exist wild in the north of India, whence they were introduced into Europe by Alexander the Great. A distinct species of pea-fowl exists in the isle of Java.

PAVO. In Astronomy, one of the southern constellations, added by Bayer.

Pawl. A catch employed on Shipboard to restrain the capstan or windlass from flying round in a reverse direction during any pause in the winding.

Pawn. [CHESS.]

Pawnbroker (Dutch pand, Ger. pfand, Fr. pan, *a pledge*; Mr. Wedgwood connects it with Lat. pannus, wearing apparel being probably the first things given in pledge). One who advances money at a certain rate of interest upon the security of goods deposited in his hands; having power to sell the goods if the principal sum, and the interest thereon, be not paid within a specified time. The practice of advancing money to the poor, either with or without interest, seems to have been occasionally adopted in ancient times; but the first public establishments of this kind were founded in Italy, under the name of Monti di Pietà. [MONT DE PIÉTÉ.] Pawnbrokers are subject to the stringent provisions of the Act 39 & 40 Geo. III. c. 99 (amended by several statutes of the present reign), under which warrants for searching premises may be obtained by those who suspect that their goods have been illegally pawned.

Pax (Lat.). An allegorical divinity among the Romans, worshipped as the goddess of peace. She had a celebrated temple at Rome, which was built by Vespasian, and was consumed by fire in the reign of Commodus. This term is sometimes applied to a small image of Christ, because, in former times, the kiss which the people gave it before leaving church was called the kiss of peace. But the common pax, or osculatorium, was a metallic plate with a crucifix engraved on it. It is now disused. (Ducange, *Osculatorium*; Milner, *Archæologia*, vol. xx. p. 534.)

Paymaster. In the Army, an officer appointed to each battalion of a regiment, or brigade of artillery, &c. He issues money to the captains of companies, troops, and batteries for the payment of their men; and examines and audits their monthly pay lists. He furnishes quarterly pay lists to the War Office, where his accounts are checked. A paymaster on joining has the relative rank of captain, and his pay and rank are improved by length of service.

PAYMASTER. In the Royal Navy, a commissioned officer employed in each ship to pay the crew, take charge of the provisions, and conduct the financial business generally.

Paymaster of the Household. An officer in the lord steward's department. This office has superseded that of the ancient cofferers. It has a salary of 450*l*. per annum.

Paymaster-General of the Forces. This office was formerly extremely lucrative, from the interest on the large sum of money which remained for a long time in the possession of the paymaster. In 1782 it was deprived of these extraordinary emoluments, and a fixed salary substituted. The paymaster is constituted by warrant under the sign manual; he is, ex officio, a member of the privy council, sometimes of the cabinet. The office is now usually held conjointly with that of the Vice-President of the Board of Trade, at a salary of 2,000*l*. a year.

Peace, Justices of. [JUSTICES.]

Peachwood. A dye-wood extensively used in calico printing. It is the produce of *Cæsalpinia echinata*.

Peacock Copper-ore. The name given by Cornish miners to massive Copper Pyrites when it is covered with a pavonine or iridescent tarnish. The most beautiful specimens are found in Cornwall at East Crinnis, and other mines in the neighbourhood of St. Austell.

Peak (this word appears under various forms in many Aryan languages, the root denoting pointedness: hence the Greek πικρός, *sharp*, πεύκη, *the fir*, from its conical growth or from its spines; Lat. picus, *the woodpecker*, and pugo or pungo, *to pierce*; Span. pico; Fr. pic; Eng. *pike*, *pick*, &c.). The upper point of the gaff, to which a fore-and-aft sail is suspended; and, occasionally, the upper posterior corner of such sail itself. The *peak-halyards* are for hoisting a flag to the peak.

Pear Oil. An alcoholic solution of acetate of amyl (amylo-acetic ether). It has a flavour and odour resembling that of certain fragrant pears, and is sold by confectioners under the above name.

Pearl. In Printing, the name of a kind of type four sizes smaller than that used in this work. [TYPE.]

Pearl Mica. A mineralogical synonym for Margarite.

Pearl Sinter. A variety of Opal found in cavities in volcanic Tufa. [FIORITE.]

Pearl Spar. The name applied to rhombohedral crystallisations of Dolomite or magnesian carbonate of lime, when they have curved faces and a pearly lustre. When the crystals are

not curved, and are coloured brown or of a reddish colour owing to the presence of from 5 to 10 per cent. of oxide of iron or manganese, they are called *Brown Spar*.

Pearls (Ital. perla, Old High Ger. berala, a form which suggests a possible affinity with Gr. βήρυλλος, *beryl*). Pearls are substances formed by certain bivalve Molluscs, consisting of concentric layers of a fine compact nacre, or substance identical with that which lines the inside of the shell; they are sometimes found free and detached within the lobes of the mantle, but most commonly adherent to the nacreous coat of the shell, which on that account is termed *mother of pearl*. The species of bivalve which produces the most valuable pearls is the pearl oyster of Ceylon, *Meleagrina margaritifera*, Lam. A pure pearl is generally spherical, and has a white, or bluish, or yellowish-white colour, with a peculiar lustre and iridescence, and consists of alternating concentric layers of membrane and carbonate of lime. When steeped in dilute muriatic acid, the carbonate is decomposed with effervescence, and films of membrane remain undissolved.

Pearls were in the highest estimation in ancient Rome, and bore an enormous price. (Plin. *Hist. Nat.* lib. ix. c. xxxv.) Their price in modern times has very much declined, partly, no doubt, from changes of manners and fashions, but more, probably, from the admirable imitations of pearls that may be obtained at a very low price. When the pearls dwindle to the size of small shot, they are denominated *seed* pearls, and are of little value. They are mostly sent to China. One of the most remarkable pearls of which we have any authentic account was bought by Tavernier, at Catifa, in Arabia, a fishery famous in the days of Pliny, for the enormous sum of 10,000*l.*! It is pear-shaped, regular, and without blemish. The diameter is 63 inch at the largest part, and the length from two to three inches. It is in the possession of the shah of Persia.

The pearl oyster is fished in various parts of the world, particularly on the west coast of Ceylon; at Tuticoreen, in the province of Tinnevelly, on the coast of Coromandel; at the Bahrein Islands, in the gulf of Persia; at the Sooloo Islands; off the coast of Algiers; off St. Margarita, or Pearl Islands, in the West Indies, and other places on the coast of Columbia; and in the bay of Panama, in the South Sea. Pearls have sometimes been found on the Scotch coast, and in various other places.

Pearlash. Impure carbonate of potash. [Potash.]

Pearlstone. A variety of Obsidian of a pearly lustre, and of various tints of grey, yellow, brown, or red. When felspathic rocks have undergone perfect fusion, those portions of the mass which have cooled the slowest, frequently contain rounded or spherical nodules of a clear grey colour, which have been compared to Pearls, and have caused the name Pearlstone to be given to the rock. The kernels or grains have received the name of Spherulite, from their spherical shape.

Pearlwhite. The subnitrate of bismuth; formerly used as a cosmetic under the above name.

Peasant Proprietor. In Political Economy, a person who is himself the owner of the soil, and who cultivates it, by his own labour, for his own subsistence. This term is employed, by Mr. Mill and others, to designate the social and economical condition of the largest portion of agricultural labourers throughout Europe and the New World. Owing to the system of subdivision, which has always prevailed in countries where the civil code has been the foundation of municipal law, land is held in small portions. This state of things is intensified in a country like France, where the subdivision of a deceased person's estate, among all his lineal descendants, is compulsory. It must take place, to a greater or less extent, where the habits or the needs of a community lead the mass of the people to agricultural pursuits.

Great difference of opinion has been expressed as to the effect of the subdivision of the soil. Some writers, as Mr. Mill, have strenuously advocated the system; this author having even proposed, as a remedy for several acknowledged social inconveniences in this country, that future enclosures should be always effected on the principle that land so taken into cultivation should be guaranteed to permanent occupiers of a peasant character. Others, like the late Mr. M'Culloch, appear to consider that the system prevailing in England, by which it is all but impossible for the peasant to become a proprietor, is faultless, and that the maximum of advantage is obtained by it.

Peastone. [Pisolite.]

Peat (a word of doubtful origin). One of the varieties of mineral fuel, the least altered from original vegetable structure. Peat and turf are accumulations of many kinds of vegetable matter collected round the roots and stalks of plants, and all in some stage of decomposition. Near the surface this substance is light coloured and spongy, and the vegetable matter is little altered; deeper, it is brown, dense, and decomposed; at the bottom it is black, and nearly as dense as coal.

As a fuel, peat contains both water and ash, and is thus in a double sense uneconomical. The water cannot be driven off by mere air-drying, for turf that is apparently dry still contains 25 per cent. of water. Well dried under cover, it retains about 10 per cent. of water, but is then wanting in density.

Turf yields a vast body of inflammable ingredients, and flames very readily; but it is difficult though not impossible to obtain intense heat from it. When artificially solidified, it is very dense.

By distillation turf yields several ingredients of considerable importance and value. The coke thus obtained generally contains rather an undue proportion of ash.

Peat smoke communicates a peculiar flavour to all the articles with which it comes in contact; and this flavour is considered a characteristic of spirits which have been distilled in vessels heated by this kind of fuel, and also of malt, corn, and fish which have been dried by it. Peat abounds in every part of the world, but more especially in the cold moist climates of temperate regions. It covers many thousand acres in Ireland, in the Highlands and western counties of the Lowlands of Scotland, and in the western counties of England; but drainage and cultivation are rapidly diminishing the extent of all these bogs.

When peaty matter accumulates on the sides of declivities it is generally comparatively dry, and is then called *hill peat*; but when peat accumulates on hollow places, or on flat surfaces, it is generally thoroughly saturated with water, and is then called *peat bog*. In most cases the principal plant which forms the peaty matter is the *Sphagnum palustre* or Bog-moss, common on all moist peaty surfaces throughout Europe, and frequent in many parts of North America. This moss continues growing upwards from the points of the shoots, while decay is advancing in a similar manner from their lower extremities, thus forming a thick close mass of vegetable matter, which rots below as it increases in height. The rotten part is frequently dug out and dried, to be used as fuel, or to be mixed with dung or lime and rotted into manure. The quantity of turf used as fuel in various parts of Europe is much greater than is generally imagined.

When peaty matter accumulates on a surface which abounds in springs, the water sometimes oozes out beneath the peat, and between it and the natural soil, in such quantities as to raise up the layer of peat, and float it off to a distance; sometimes carrying everything before it, and ending by burying under it lands in a state of culture. About the middle of the eighteenth century, a remarkable irruption of this kind took place near Annan in Dumfriesshire; and such eruptions are frequent in Ireland. The circumstances favourable to the growth of peat are: a soil abounding in springs, a flat surface or hollow surrounded by hills, and a moist climate. Hence peat bogs are more abundant in Ireland, and in the western counties of Scotland, than in any other part of the British Empire.

When an accumulation of peat has taken place in a level situation, or on a declivity not abounding in springs, the matter accumulated is comparatively dry, and is then called *peat moss*. One of the most remarkable peat mosses in Britain is the Flanders Moss, in Stirlingshire. It rests on a flat surface of excellent alluvial soil, of which it covers about 4,000 acres. Great part of this peat moss, being quite light, has been cut into small pieces, and floated off by means of a stream of water to the sea; thus exposing the natural soil, and rendering it fit for culture. This operation was commenced at Blair Drummond, towards the end of the last century, by the celebrated Lord Kames, and is still continued by his son, Mr. Drummond.

Peat Soil. When peat is in a state of decomposition, corn or agricultural crops may be grown on it, after it has received additions of earthy matter. The process of turning living peat into peat soil is greatly facilitated by draining, and by laying earth or lime on its surface, and afterwards mixing the earthy matter with the peat by ploughing or digging. The soil is thus benefited by the pressure of the earthy compost as well as by the ingredients which it adds. A crop of rape may then be taken after a dressing of bone dust; and this may be followed by potatoes. In this manner every kind of peaty surface may be rendered available for agricultural purposes; and accordingly, in Ireland, in Lancashire, and in Ayrshire, good crops of corn, potatoes, and artificial grasses are produced on the surface of peat lands, which consist of a layer of peat from five to twenty feet in depth. The plants which thrive best on the surface of beds of peat of this description are those which extend their roots immediately under the surface. Hence few trees will thrive in such soils, with the exception of the spruce fir, the silver fir, the birch, and two or three kinds of willow. Peat soil is extensively used in gardening, in the culture of such plants as are found growing on similar soil in a wild state, and also as an ingredient in the artificial composition in which choice exotics are planted.

Peat from wood, or *woody peat*, is a composition of the branches, trunks, and roots of trees, with their leaves, and the shrubs and plants which have grown up among them, which have lain so long in water as to have decayed into a mass soft enough to be cut with a spade. The colour is a blackish brown, like that of mossy peat; and it may be used as manure, for fuel, and for the growth of plants. Peat of this description is found in some parts of Holland, and also in the Vale of Kennett, in Berkshire; but is most abundant in North America, where it forms the soil in which many of the plants and trees of that country thrive with the greatest vigour. Wherever it can be found, it is the most suitable of all kinds of peat for garden purposes. This kind of peat is frequently burnt both in Britain and Holland, for the sake of its ashes, which, from the alkali contained in them, are found an excellent manure.

Sandy peat is mossy peat decayed to an earthy state, and naturally mixed with sand brought over it, from soil lying above its level, or by the overflowings of rivers. It is used in gardening for the same purposes as peat, and is known as heath soil.

Peat-charcoal, which is formed by charring the dead layers of peat in proper furnaces, is employed as an absorbent of ammoniacal and other gases, and a deodoriser of putrescent animal and vegetable matters, and in this state it is beneficial as a manure, both for agricultural and horticultural purposes. In the pure

state, it is also a useful ingredient in garden composts.

Peats. Peat bog cut out in small square or rectangular pieces, and dried for being used as fuel. These pieces are cut with light spades in the summer season, spread abroad to dry, and afterwards carted home and put up in stacks, or heaps, which are thatched to exclude the · These peats are afterwards used as fuel, not only for domestic purposes, but for burning lime, and for heating kilns for drying corn, &c. To facilitate the drying of peat, the water is sometimes pressed out of the square pieces after they are cut, and thrown out of the bog, by a compressing machine, which also renders the material more compact and durable in the fire. Peats are also sometimes charred by a smothered combustion, so as to be rendered better adapted to serve as a substitute for pit coal, coke, or charcoal, in smelting iron or other metals, in generating steam, &c. Attempts have been made to separate astringent matter from peat, and to use it in tanning leather.

Pebbles (A.-Sax. pabol). A name given to roundish nodules and geodes, especially of silicious minerals, such as Rock-crystal, Agate, &c.; but commonly and more correctly applied to small fragments of rocks and minerals which have become rounded and water-worn like the shingle forming the beach on a sea-shore. Thus, pebbles may be composed of any rock or mineral; as, for example, of sandstone, quartz, limestone, flint, &c. When of considerable size, they are called *boulders* or *boulder-stones*. Pebbles of gold are known by the name of *nuggets* or *pepitas*. In a technical sense, the term *pebble*, among opticians, generally means the transparent and colourless rock-crystal or quartz (pure silica) which is used as a substitute for glass in spectacles: its extreme hardness renders it more durable, and less liable to become scratched.

Pecari. An Artiodactyle quadruped allied to the hog; but generically distinguished by the absence of the outer toe of the hind foot, and the presence of a peculiar gland, which exudes its secretion by an orifice situated on the back; whence Cuvier devised the name *Dicotyles* (two navels) for the genus. The incisor and molar teeth resemble those of the hog, but the canines do not project from the mouth. The metacarpal and metatarsal bones of their two middle and largest toes are confluent, as in the Ruminants, with which their stomach also, divided into three compartments with cæcal appendages, presents a marked analogy. Two species of pecari are known, both natives of South America; viz. the collared pecari (*Dicotyles torquatus*) and the white-lipped pecari (*Dicotyles labiatus*, Cuv.).

Pechblend or **Pitchblende.** An ore of uranium. It is an impure oxide of that metal.

Peck. A measure of capacity containing two gallons, or the fourth part of a bushel. The imperial peck contains 554·55 cubic inches. [MEASURE.]

(Lat. *cattle*). The name given by Linnæus to an order of Mammals ‹ sponding with the Ruminantia of Cuvier.

Pecten (Lat. *a comb*). In Comparative Anatomy, the vascular membrane, in structure resembling the choroid, plicated with parallel folds like the teeth of a comb, and extending, in the eyes of birds, from the back of the retina through the vitreous humour to, or near to, the crystalline lens, where it mostly terminates in a point. This organ resembles a flattened conical bag, whence it is also termed *marsupium*.

In Zoology, the name is applied to a genus of bivalve shells. They have a hinge like that of the oyster; but have been removed on account of their shell being inequivalve, semicircular, always regularly marked with ribs, which radiate from the summit of each valve to the circumference, and furnished with two angular productions, called *ears*, which widen the sides of the hinge.

The animal is chiefly remarkable for the little dark green shining globule which terminates most of the tentacles of the exterior row of those at the circumference of the mantle. These specks are conjectured to be rudimental organs of vision, whence Poli was induced to call the soft parts of the pecten *argus*.

Pectine, Pectic Acid, Pectose. *Vegetable jelly.* A gelatinous principle has long been recognised as one of the proximate components of vegetables: it is derived, according to Frémy, from the presence of *pectose* (Gr. πηκτός, *coagulated*), a substance usually associated with the cellular tissue, and which is insoluble in water, alcohol, and ether, but which under the influence of acids, aided by a gentle heat, becomes converted into a soluble gelatinous substance, *pectine*, represented by the formula C_{64}, H_{48}, O_{64}.

Pectine is found ready formed in the juices of ripe fruits, in consequence of the action of their acids upon the original *pectose*. It may be obtained from the expressed juice of ripe pears or apples (after the lime which it contains has been precipitated by oxalic acid, and the albumen by a strong solution of tannin), by means of alcohol, which throws it down in gelatinous filaments. When pure, it is white, neutral, not crystallisable, soluble in water, but insoluble in alcohol and in ether: it is precipitated by subacetate, but not by neutral acetate of lead. When its aqueous solution is long boiled, it loses viscosity, and is changed into *parapectine*.

Pectine and its modifications are changed into *pectic acid* by the action of weak alkaline solutions. Pectic acid is generally obtained by boiling the pulp of certain roots, of carrots for instance, with a very weak solution of an alkaline carbonate, and precipitating by chloride of calcium; the precipitate, after having been well washed, is decomposed by dilute hydrochloric acid, which leaves the pectic acid in the form of a jelly, insoluble in cold water.

Pectic Fermentation.—Pectose always associated with a substance which Frémy calls *pectose*, having a special action upon it (as diastase has upon starch), and which he represents as the *ferment* of the gelatinous products. It is obtained by adding to fresh carrot juice, alcohol, which throws it down in an insoluble form, but it retains its characteristic properties. It transforms pectine (at a temperature between 80° and 90°) into a substance insoluble in cold water (*pectosic acid*), and subsequently into pectic acid, as above described. None of these pectic compounds exert any rotatory action on polarised light.

There are many Algæ, Fuci, and Lichens, which abound in a peculiar gelatinising principle. One of the most remarkable is the *Gelidium corneum*, from which an article is prepared known commercially as *Japan isinglass*. It is insoluble in cold, but soluble in hot, water, and sets into a firm jelly on cooling, even when it forms only 1-120th part of the weight of the water. One part of isinglass (animal gelatine) produces a similar jelly with about 80 parts of water. Unlike animal jelly, it is not precipitated by tannic acid. It has been proposed to substitute it for the varieties of animal gelatine, but it is destitute of nitrogen, having the formula $C_{24}H_{21}O_{24}$. The edible birds' nests, esteemed as a delicacy in China, are constructed by a species of swallow, of the *Plocaria candida*.

Pectinate (Lat. pectinatus, from pecten, *a comb*). In Botany, a term applied to that form of marginal division in which the segments are numerous, narrow, and closely placed, so as to resemble the teeth of a comb.

Pectinibranchiates (Lat. pecten, and branchia, *gills*). The name given by Cuvier to his sixth order of Gastropoda. It is the most extensive division of that class, since it includes almost all the spiral univalve shells, as well as several which are merely conical. The order is thus characterised by Cuvier: 'The branchiæ, composed of numerous leaflets or fringes, ranged parallel like the teeth of a comb, are affixed in two or three lines (according to the genera) to the floor of the respiratory cavity, which occupies the last whorl of the shell, and which communicates outwards by a wide aperture between the margin of the cloak and the body. Two genera only—*Cyclostoma* and *Helicina*—have, instead of branchiæ, a vascular network clothing the ceiling of the cavity, in all respects the same as that of the order; and they are the only ones which respire the atmosphere, water being the medium of respiration to all the rest.'

All the Pectinibranchiates have two tentacula and two eyes, raised sometimes on pedicles; a mouth in the form of a proboscis, more or less lengthened; and separate sexes. The penis of the male, attached to the right side of the neck, cannot in general be drawn within the body, but is reflected into the branchial cavity; it is sometimes very large. The *Paludina* alone has the organ concealed, and it comes out through a hole pierced in the right tentaculum; the rectum and the oviduct of the female also creep along the right side of the branchial cavity; and there is between them and the branchiæ a peculiar organ, composed of cells filled with a very viscous fluid, the use of which is to form a common envelope for the enclosure of the eggs, and which the animal deposits with them. The form of that envelope is often very complicated and remarkable.

The tongue is armed with little hooks (or curved spinules), and wears down the hardest bodies by slow and oft-repeated frictions.

The grand difference between these animals lies in the presence or absence of the canal formed by the prolongation of the margin of the branchial cavity on the left side, and which passes along a similar canal or sinus in the shell, to enable the animal to breathe without leaving its shell. There is also this distinction between the genera, that some want the operculum; and the species vary in the filaments, fringes, and other ornaments that deck the head, the foot, or the cloak.

Pectolite (Gr. πηκτός, *fixed*, as being bound together, and λίθος, *stone*). A hydrated silicate of lime and soda, which occurs in white or greyish spheroidal masses composed of an aggregation of acicular crystals, or of delicate fibres arranged in a radiated or stellar form. It is found in Scotland, on the shore near Landelfoot, and at Knockdolian Hill in Ayrshire, at the Ratho quarries near Edinburgh, and in Skye.

Pectorals or **Pectoral Fins** (Lat. pectoralis, *belonging to the breast*). The anterior and lateral pair of fins, which represent, in fishes, the fore legs or anterior members of other vertebrate animals.

Peculation (Lat. peculator, *a thief*). A term of the Roman Law, rendered in that of France by *concussion*. The embezzlement by a public officer of public money. Peculation, in the Roman law, also comprehended offences relating to the coin.

Peculiar. In Ecclesiastical Law, an exempt jurisdiction, which is not under the ordinary of the diocese, but has one of its own. They are: royal, of which the king is ordinary; peculiars of archbishops, bishops, deans, chapters, prebendaries, and the like; to which were formerly added peculiars of monasteries, the jurisdiction over which, by 31 Hen. VIII. c. 13, was granted to the ordinary within whose diocese they were situated, or to such persons as the king should appoint. For some purposes connected with pluralities and non-residence, benefices exempt or peculiar are now made subject to the jurisdiction of the archbishop or bishop within whose diocese they are locally situated (1 & 2 Vict. c. 106).

Peculium (Lat.). In the Roman Law, the property which a slave might acquire independent of the control of his master. This property was frequently permitted to accumulate, so as to enable the slave to purchase his freedom. The son being, on the principles of the Roman

law, unemancipated during the lifetime of his father, whatever property he might acquire appertained in strictness to the latter; but, by degrees, certain species of property acquired by the child obtained the title and character of *peculium*. Of these, however, the only one which was absolutely the child's was that which the son acquired in military service (peculium castrense), or in public service of any kind, which by a legal fiction was regarded as equivalent to military.

Pedagogue (Gr. παιδαγωγός; from παῖς, *boy*, and ἀγωγός, *leader*). Among the ancient Greeks, a slave charged with the personal care of a boy from the earliest age after infancy (from the milk, in the loose phrase of Plutarch; from about the age of seven, as it is more accurately stated by Æschines) until he became a youth (μειράκιον), i.e. until the seventeenth or twentieth year. The pedagogue's duty was to attend his charge on all occasions when he left his father's house; to the lecture rooms of masters, the theatre, &c. (Plato, *Sympos.*) He was also intrusted with the duty of instructing and disciplining the child in inferior branches of education and ordinary manners. He was, consequently, of a very superior order of common slaves, and must be understood as excepted when Aristotle recommends that a child should be left to converse as little as possible with persons of the servile class. (*Politic.* vii. 156.) The custom of intrusting children to slaves in this manner was common in other Grecian states; the Romans also employed a slave for similar purposes, with the title of *custos* or *magister*.

Pedal Clavier. On the organ, a row of keys intended to be played on with the feet, and which in large instruments actuate a separate organ, called the pedal organ. The invention of the pedals or foot-keys of the organ is attributed to a German named Bernhard, who lived in the fifteenth century. It was long, however, before their utility and importance were acknowledged by other nations; and it is a singular fact, that though England was the first to introduce the organ generally into the church, she was the last to adopt this invention. Within the last twenty years the use of the foot-keys has been much extended, and few organs are now built without them.

Pedal Curves and Surfaces. The locus of the feet of perpendiculars let fall from a given point *o*, the *pedal origin*, upon all the tangents of a given (*primitive*) curve or upon all the tangent planes of a given surface, is called the *pedal* of that curve or surface. From this definition it follows at once that the inverse of a pedal is the reciprocal of the primitive. The pedal of a curve or surface S being denoted by S_1, the pedal of the latter is represented by S_2, and termed the *second pedal* of the primitive, and so on. The curves or surfaces thus obtained are said to form a series of *positive pedals*, in order to distinguish them from the series of *negative pedals*, obtained by reversing the above process. Thus the curve or surface S_{-1}, whose first positive pedal is the primitive itself, is called the first *negative* pedal of the latter, and similarly the second negative pedal of S, which is the first negative pedal of S_{-1}, would be represented by S_{-2}, and so on. Just as S_1 is the inverse of the reciprocal of S, so S_{-1} is the reciprocal of the inverse of S; in other words, the processes of reciprocation and inversion applied consecutively to the primitive lead to the first positive or first negative pedal, according as the one or the other operation is first performed. Although pedal curves were studied as early as 1720 by Maclaurin, in his admirable *Geometria Organica*, they do not appear to have received any distinctive name in England until 1862, when Dr. Salmon, in his *Analytical Geometry of Three Dimensions*, proposed to adopt the present English translation of the French term *courbes podaires*. It was under the too general title of *derived curves* that the Rev. W. Roberts of Dublin, in the *Philosophical Magazine* 1843, and in Liouville's *Journal* 1845, first examined the properties of a complete series of pedal curves, and introduced the useful and natural distinctions of positive and negative pedals. In 1859 Mr. Roberts' investigations were extended to a complete series of pedal surfaces by Prof. Hirst, in the *Annali di Matematici*, t. ii., and in the *Quarterly Journal of Mathematics*, vol. iii.

The reciprocals of the several pedals

$$S_{-n}, \ldots\ldots S_{-1}, S, S_1, \ldots\ldots S_n,$$

of any complete series form another series of pedals

$$S'_n, \ldots\ldots S'_1, S', S'_{-1}, \ldots\ldots S'_{-n},$$

whose terms are arranged in contrary order. In other words, the reciprocal of the n^{th} positive pedal of S is the n^{th} negative pedal of S′, the reciprocal of S. This will be at once evident on observing that S_1 is the inverse of S′, and consequently that the reciprocal of S_1 must be the first negative pedal of S′. In the same way the inverse of the n^{th} pedal is the $(-n)^{th}$ pedal of the inverse, and, we may add, the $-(n-1)^{th}$ pedal of the reciprocal. By means of these relations the equations of negative pedals can often be obtained from those of positive ones by very simple substitutions.

With respect to the areas and volumes of pedals, several very general relations have been established. Steiner has shown that if the primitive be a closed curve, but in other respects perfectly arbitrary, the origins of first positive pedals of the same area all lie in the circumference of a circle, whose centre is the origin of the pedal of least area. If the primitive be not closed, then the pedal will also be unclosed; but if we consider the area to be represented by that of the vector formed by the pedal and its extreme radii, it can be shown that the locus of the origins of pedals of constant area is a conic. (Crelle's *Journal*, vols. xxi. and l.) Extending Steiner's results to surfaces, Mr. Hirst has shown that the locus

of the origins of first positive pedals of equal volume is in general a surface of the third order, but that for any *closed* primitive surface the origins of pedals of equal volume lie on a quadric surface (e.g. ellipsoid) whose centre is the origin of the pedal of least volume. (*Phil. Trans.* 1863.)

The pedals of the ellipsoid

$$\frac{x^2}{a}+\frac{y^2}{b}+\frac{z^2}{c}=1$$

possess considerable interest, and have accordingly been most investigated. The first positive central pedal is the well-known surface of elasticity of Fresnel. [ELASTICITY, SURFACE OF.] Its equation may be easily obtained from the foregoing relations. In fact, the reciprocal of the given ellipsoid has the equation

$$ax^2+by^2+cz^2=1,$$

and the inverse of this, the first pedal of the primitive, is obtained by replacing x, y, z, by $\frac{x}{r^2}$, $\frac{y}{r^2}$, $\frac{z}{r^2}$, where $r^2=x^2+y^2+z^2$, hence

$$ax^2+by^2+cz^2=(x^2+y^2+z^2)^2$$

is the equation required. The equation of the first negative pedal was first obtained by Cayley. (*Proc. of Royal Soc.* 1858, and *Annali di Matematici* 1859.) It is a surface of the tenth order, and may be defined as the envelope of planes drawn perpendicular to the central radii of an ellipsoid through their extremities. The inverse of this surface is, according to Hirst's general relations, the second positive pedal of the reciprocal ellipsoid; so that, putting

$$\frac{x}{r^2},\ \frac{y}{r^2},\ \frac{z}{r^2},\ \frac{1}{a},\ \frac{1}{b},\ \frac{1}{c},$$

for $x, y, z, a, b, c,$ respectively in Cayley's equation, that of the second positive pedal of the primitive ellipsoid is at once obtained. With respect to the volumes of the first positive pedals of the ellipsoid, that of the central pedal has been calculated by Tortolini (Crelle's *Journal* 1844), and Mr. Hirst has shown that from this the volumes of all other first pedals may be obtained by simple differentiation.

Pedal Harmonics. In Music, the same as PEDAL POINT.

Pedal Point or **Organ Point.** In Music, a passage in which a certain bass note, usually either the dominant or tonic, is held down for a long time, while the upper harmony changes repeatedly, and the various parts perform figured movements. It is so called because it is done on the organ by holding down one of the pedal keys.

Pedals (Lat. pedalis, *belonging to a foot*). In the pianoforte, harp, and organ, are also levers or stops to be worked with the feet, and intended to modify the tone, or to produce mechanical changes in the instrument in order to give certain effects desired by the player.

Pedaliaceæ (Pedalium, one of the genera). A natural order, of small extent, belonging to the perigynous Exogens of the Bignonial alliance. They are characterised by having a bony or capsular fruit, parietal placentæ, an amygdaloid embryo, and a short radicle. They are herbaceous tropical plants. *Sesamum*, one of the genera, yields Gingilie oil; the fresh branches of *Pedalium murex* render water or milk mucilaginous, and the genus *Martynia* yields some handsome garden plants.

Pedalmaschi. A Turkish officer, whose duty consists in looking after the interests of the sultan in cases of legacies. The Ottoman treasury receives through this officer a tithe of all bequests made to heirs male.

Pedate. In Botany, a palmate leaf, with the two lateral lobes themselves divided into smaller segments, the midribs of which do not run directly into the common central point; as in the leaf of *Dracunculus vulgaris* or *Helleborus fœtidus*.

Pedestal (Lat. pes, *a foot*). In Architecture, the substructure to a column or a wall. The component parts of a pedestal are three; the base, the die, and the cornice. The whole height of a pedestal is from one quarter to one third of the height of the column, with its entablature.

Pedicel (Lat. pes). In Botany, one of the ultimate ramifications of that part of the inflorescence called the *peduncle*. Hence the term *pedicellate*, applied to stalked flowers borne on a branched inflorescence.

Pedicellates (Lat. pes). The name of an order of Echinoderms, comprehending those which have the vesicular pedicellate organs, which are termed feet in this class, but which project from various parts of the surface of the body.

Pedimanes (Lat. pes, and manus, *a hand*). The name of a family of Marsupial animals, of which the opossum (*Didelphys*) is the type; they are distinguished by the opposable property of the hinder thumb or hallex, the fore feet being organised like those of ordinary Unguiculate quadrupeds.

Pediment (Lat. pes). In Architecture, the low triangular mass representing the gable of a roof, over the front of a building, portico, door, window, &c. A pediment is frequently ornamented with sculpture. The heights of pediments are seldom more than two-ninths of their width. According to L'Éveillé, *Considérations sur les Frontons*, 4to. Paris 1824, the pediment is divided into three parts, the tympanum, the cornice, and the acroteria. The tympanum is the plane face, and is often ornamented with sculpture; the cornice is, as its name implies, the moulded decoration accompanying the tympanum; and the acroteria are the small pedestals usually introduced at the feet and at the apex of the pediment, to receive statues or groups of sculpture.

Pedipalps (Lat. pes, and palpo, *I touch softly*). A name given to a tribe of pulmonary Arachnidans, comprehending those which have the feelers in the form of pincers, or armed with a didactyle claw; as the scorpions.

Pedlar. [HAWKERS.]

or **Podometer** (Gr. πούς, *the foot*, and μέτρον, *measure*). An instrument for the purpose of registering the number of paces taken by a man in travelling or walking, whence the distance is ascertained. It is usually in the form of a watch, and receives its movement from the motion of the body, so that it advances one division at each step. The number of divisions may be noted by an index or hand, in the same manner as the number of vibrations of a watch-balance.

Peduncle (Lat. pes, *a foot*). In Botany, that part of an inflorescence which proceeds immediately from the stem, and forms the support of a solitary single flower. Hence *pedunculate*, applied to stalked solitary flowers, as *petiolate* is to stalked leaves. A peduncle supporting several flowers at its apex is called a *scape*.

Pedunculates. The name of an order of Cirripeds, comprehending those which have the body supported by a flexible tubular stem.

Peep-o'-Day Boys. The well-known appellation of certain insurgents who appeared in Ireland in 1784. They obtained this name from visiting the houses of their antagonists, called *defenders*, at break of day in search of arms.

Peer (from Lat. par, Fr. pair, *equal*). This word still retains its original meaning in the language of the common law, as trial by jury is said to be by the peers, or equals, of the defendant. In this sense, the name remains as a relic of feudal institutions, according to which every rank of society formed an association for the purpose of mutual defence and the decision of disputes; as the tenants of a lord paramount or inferior, who met as equals (pares curiæ) in the court over which he presided. Hence, in the French monarchy, the highest vassals of the crown formed a rank apart, and were called *pares* or *peers* with reference to each other; and the designation became a title of honour. The peers of France differed in number at different periods of the early French monarchy, as their domains became united to the crown; but according to heraldic theory, there were six temporal—the dukes of Burgundy, Aquitaine, and Normandy, and the counts of Flanders, Toulouse, and Champagne; and six spiritual—the archbishop of Rheims, and the bishops of Laon, Beauvais, Noyon, Châlons, and Langres. In later times new peerages were created, as the duchy of Brittany and counties of Artois and Anjou. At last the title remained as a simple dignity; and Louis XIV. increased the number of dukes and peers (ducs et pairs) until at last they amounted to thirty-seven. They had no privileges except precedence and a seat in the parliaments. On the restoration of Louis XVIII. hereditary peerage was established in France on the model of that of England, but was abolished in 1831; and the chamber of peers for life was itself abolished in 1848, but has since been revived as the *senate*. For the history and privileges of the English peerage, see PARLIAMENT.

Peganite. A hydrated phosphate of alumina of an emerald-green or white colour occurring in thin crusts or very small rhombic prisms with the acute lateral edges truncated, at Strigis and Frankenberg in Saxony.

Peganum (Gr. πήγανον, *the herb rue*). A small genus of *Rutaceæ*, a species of which, *P. Harmala*, common in the South of Europe, is a powerful-smelling plant, whose seeds are used in Turkey as a vermifuge.

Pegasus (Gr. πήγασος, said to have received this name from his appearing first near the fountains, πηγαί, of ocean). In Greek Mythology, the horse which, with Chrysaor (the god of the golden sword), sprang from the head of MEDUSA, when she was slain by PERSEUS. This horse, by the aid of Athena, BELLEROPHON caught near the fountain Peirene, and on it rode to encounter the CHIMÆRA. According to one version of the myth, the horse, having thrown off his rider, rose to heaven and lived afterwards in the palace of Zeus, carrying his thunder and lightning. His connection with the Muses is confined in the ancient tales to his calling forth by a blow of his hoof the fountain HIPPOCRENE (hence called by Persius *fons caballinus*) during the contest of the nine Muses with the nine daughters of Pierus on Mount Helicon. A similar origin was assigned to other wells near Corinth, Trœzen, &c.

PEGASUS. This name denotes, in Astronomy, one of the forty-eight constellations of Ptolemy, situated in the northern hemisphere.

PEGASUS. In Zoology, a genus of Lophobranchiate fishes with large pectoral fins, by means of which they are enabled to take short saltatory flights through the air.

Pegmatite (Gr. πῆγμα, *anything fixed*). A variety of granite frequent in veins in true granite. It is a granular mixture of quartz and felspar, passing into graphic granite, and like the other varieties of porphyritic rock must be regarded rather as a local variety than as due to any widely acting cause. It is a name given by the French geologists.

Pegmatolite. A mineralogical synonym for Orthoclase.

Peine Forte et Dure. In English Law, the Anglo-Norman name for the barbarous practice of pressing with weights of iron prisoners who refused to plead when indicted. [QUESTION.]

Pelagianism. The religious system of Pelagius, a British monk of the fifth century. His tenets are thus stated by a modern writer: '1. That the sins of our first parents are imputed to themselves alone, and not to their posterity; that we derive no corruption from their fate; that we inherit no depravity from our origin, but enter into the world as pure and unspotted as Adam at his creation. It was a necessary inference from this doctrine that infant baptism is not a *sign* or *seal* of the remission of sins, but only a mark of admission into the kingdom of Christ. 2. That our own powers are sufficient for our own justification; that as by our own free will we run into sin,

so by the same voluntary exercise of our faculties we are able to repent and reform, and raise ourselves to the highest degree of virtue and piety; that we are indeed assisted by that external grace of God which has taught us the truths of revelation, which opens to us our prospects, and enlightens our understanding, and animates our exertions after holiness; that the internal or immediate operation of the Holy Spirit is not necessary either to awaken us to religious feeling, or to further us in our progress towards holiness; in short, that man, by the unassisted agency of his natural perfection, under the guidance of his own *free will*, is enabled to work out his own salvation.' (Waddington's *History of the Church.*) Pelagius was condemned by Pope Innocent I.; but his sentence was annulled by his successor Zosimus. The African bishops protested in the council of Carthage, A.D. 418, and appealed to the emperor, who issued a rescript deciding on the abstruse question of theology. 'There can be no doubt,' says Dean Milman, 'that the law was obtained by the influence of the African bishops with the emperor or his ministers; there is great likelihood, by the personal authority of Augustine with the Count Valerius. This appeal to the civil magistrate is but another instance that the ecclesiastical power has no scruple in employing in its own favour those arms of which it deprecates the use, the employment of which it treats as impious usurpation when put forth against it. By this law it became a crime against the state, to be visited with civil penalties, to assert that Adam was born liable to death. The dangerous heresiarchs were condemned by name, and without hearing or trial, to banishment from Rome.' Yielding submission to this rescript, Zosimus anathematised the doctrine of Pelagius in a circular letter addressed to all the bishops of Christendom. Eighteen bishops alone, of those who took this letter into consideration, refused to condemn their fellow-Christians unheard, and appealed to a general council. Amongst these the most eminent was Julianus, bishop of Eclana, in Campania, the founder of what has been termed Semi-Pelagianism. The opinions of Julianus were adopted by the monk Cassianus, who settled at Marseilles, and was followed by Vincentius, and Faustus bishop of Riez.

Of Pelagius, Dean Milman says, that he 'came too early for any calm consideration of his doctrines, or any attempt to reconcile the difficulties which he suggested, with the sacred writings. In his age the religious sentiment was at its height, and to the religious sentiment that system was true which brought the soul most strongly and immediately under divine agency. To substitute a law for that direct agency, to interpose in any way between the Spirit of God and the spirit of man, was impiety, blasphemy, a degradation of God and of His sole sovereignty. This sentiment was at its height in Western Christendom. In no part had it grown to a passion so overwhelming as in Africa; in no African mind to such absorbing energy as in that of Augustine.' (*History of Latin Christianity*, book ii. ch. ii.)

Pelagosaurus (Gr. πέλαγος, *the sea*, and σαῦρος, *a lizard*). A genus of large extinct amphicœlian crocodile, the remains of which characterise the upper Jurassic formations.

Pelargonic Acid. A liquid found in the oil of *Pelargonium roseum.* In combination with oxide of ethyl it is frequently used as the flavouring agent of whisky.

Pelargonium (Gr. πελαργός, *a stork*). A very extensive genus of plants, called *Stork's bill*, occurring chiefly in South Africa, and belonging to the order *Geraniaceæ.* They form, in fact, the Geraniums of our greenhouses and summer flower gardens, though the true Geraniums are somewhat different. Few of our garden flowers are more popular than these, which now appear in at least four principal subdivisions, known as Show Pelargoniums, in which the two upper petals are usually clouded or veined, and dissimilar from the three lower ones; Fancy Pelargoniums, a smaller growing race, chiefly with lighter-coloured flowers; French Pelargoniums, in which appear brighter tints of colour, often shaded; and Scarlet Pelargoniums, as they are called, but which vary with colours of almost every shade, the flowers of which are nearly whole coloured, and the stems and leaves more succulent. The latter, in their various subdivisions, are much used for decorating summer flower gardens or parterres.

Pele's Hair. A capillary form of Obsidian from Hawaii. (*Descriptive Catalogue of the Rock Specimens in the Museum of Practical Geology*, 3rd edition.)

Pelecanidæ (Gr. πελεκάν). The name of a family of swimming birds, of which the pelican (*Pelecanus*) is the type.

Peleus. [PARIS; THETIS.]

Pelican. [PELECANIDÆ.]

Pelicanite. A variety of Cimolite resulting from the decomposition of the felspar in the granite of Kiew in Russia.

Peliom (Gr. πελιός, *livid*). A smoke-blue variety of Iolite from Bodenmais in Bavaria.

Pellagra (Lat. pellis, *the skin*). A disease of the skin somewhat resembling *elephantiasis*, and occasionally producing great constitutional derangement. It is endemic in certain districts of Italy, especially in the Milanese.

Pellicle (Lat. pellicula, dim. of pellis). A thin membrane. In Chemistry, the term is applied to the film of salt or other substances which forms upon the surface of solutions during evaporation.

Pellitory (Span. pelitre). The common name for one of our wild plants, *Parietaria officinalis*, also known as Pellitory of the Wall.

Pellitory of Spain. The root of the *Anacyclus Pyrethrum.* It has a pungent flavour, and when chewed promotes the flow of saliva, and is often useful in toothache.

Pells, Clerk of the. An officer of the Exchequer whose duty it was to make entries

on parchment rolls (*pelles*). The office was abolished in 1834.

Pelokonite (Gr. πελός, *ash-coloured*, and κόνις, *powder*). A variety of Cupreous Manganese, found, associated with Chrysocolla, in Chili.

Pelops. [TANTALUS.]

Peloria (Gr. πέλωρ, *a monster*). A term applied to those flowers which change from their usual normal irregular form, to one which is abnormal in developement as regards the particular family to which they belong. Instances occur in the Snapdragon and the Toadflax, which being normally irregular, sport to a regular form. The erect-flowered Gloxinias of modern times, which have changed from the typical deflexed-flowered *G. speciosa*, are likewise instances of Peloria.

Pelosine (Gr. πελός, *dusky*). A bitter extractive matter obtained from the root of the *Pareira brava, Cissampelos pareira.*

Pelottes de Neige. The French name for the Gueldres Rose, or Snowball-tree, a sterile-flowered variety of *Viburnum opulus*, in which the white flowers are collected into large round clusters like snowballs.

Pelta (Lat., *a shield*). In Botany, a term used in describing lichens to denote a flat shield without any elevated rim, as in the genus *Peltidea.*

Peltasts (Gr. πελταστής). Light-armed infantry were so named among the Greeks, from carrying the πέλτη, *pelta*, or target.

Peltate (Lat. peltatus, from pelta, *a shield*). In Botany, a leaf or any other organ which is fixed to the stalk by the centre or by some point distinctly within the margin, as in the *Tropæolum.*

Peltophorum (Gr. πελτοφόρος, *shield-bearing*). The name of a genus of Cæsalpineous *Leguminosæ* which yields Brazilletto wood. This, which is an orange-coloured dye wood imported from Jamaica and San Domingo, is provided by a tree now called *Peltophorum Linnæi*, but formerly *Cæsalpinia brasiliensis.* From 200 to 400 tons of this wood are annually imported.

Peltry (Lat. pellis, *a skin*). The name given to the skins of different kinds of wild animals found in high northern latitudes, particularly in America; such as the beaver, sable, wolf, bear, &c. When the skins of such animals have received no preparation, they are termed *peltry*; but when the inner side has been tanned by an aluminous process, they are denominated *furs.*

Pelvis (Lat.). The inferior part of the abdomen, the bony circumference of which is formed by the two *ossa innominata*, each composed of an *ilium*, an *ischium*, and *pubis*, the *sacrum*, and the *os coccygis.* It contains the rectum, the urinary bladder, and internal organs of generation.

Pemmican. A kind of potted meat used by Captain Parry in his polar expedition. It is prepared by drying thin slices of the lean of meat over wood fires, then pounding it, and, lastly, mixing it with about an equal weight of its own fat.

Pemphigus (Gr. πέμφιξ, *a pustule*). A fever attended by almond-shaped vesicular eruptions.

Penæaceæ (Penæa, one of the genera). A small natural order of Monochlamydeous plants, referred by Lindley to the Rhamnal alliance. They are shrubs found at the Cape of Good Hope, and are chiefly remarkable for their apetalous flowers, their four-celled ovary, and their minute or rudimentary cotyledons. The gum-resin called *Sarcocol* is said to be produced by some of the plants of this order, especially by one called *Penæa sarcocolla*, now sometimes separated under the latter name; but this statement requires confirmation.

Penal Servitude. In the Law of England, a species of punishment of which the legal existence dates from 1853, when, by the Act 16 & 17 Vict. c. 99, it was substituted in various cases for transportation. Penal servitude for four years was reckoned equivalent to transportation for seven; and so on in similar proportion. The punishment was defined as consisting of imprisonment with hard labour either in the United Kingdom or in any part of the dominions beyond seas (practically, that is, the public works at Bermuda and Gibraltar). In 1857, by the Act 20 and 21 Vict. c. 3, the sentence of transportation was abolished: terms of penal servitude of the same length being substituted for terms of transportation in the cases to which the latter was still applicable. But it was provided that the sentence of penal servitude may be carried into effect (in these cases) out of the kingdom.

Penalty (Lat. pœna, *punishment*). Penalties are of three kinds, says Lord Coke; *pœna pecuniaria, pœna corporalis*, and *pœna exilii.* Where anything is prohibited by statute under a pecuniary penalty, if the penalty, or part of it, be not appointed by the statute to the informer, it goes to the crown. Penal statutes are to be construed strictly. [STATUTE.]

Penance. [PENITENCE.]

Penang Lawyers. The name under which are imported the stems of *Licuala acutifida*, a kind of palm found in the island of Pulo Penang. They are converted into walking-sticks.

Penates (Lat.). The household gods of the ancient Italians, who presided over families, and were worshipped in the interior of each dwelling. The term is connected with *penus*, a store of food; they were worshipped in the penetralia. Penates is, in fact, a generic term, including the Lares, with whom they are continually mentioned in conjunction. As there were public as well as domestic Lares, so there were public Penates, who exercised a general influence over the destinies of the whole Roman people. Thus Tacitus relates, that the shrine of Vesta with the Penates of the Roman people was consumed, along with other temples, in the great fire during

the reign of Nero. (Müller, *Etruscans*, vol. ii. p. 90, &c.; Hartung, *Religion der Römer*, &c.)

Pencatite. A variety of Predazzite or Hydrodolomite, found on Vesuvius, and at Predazzo in the Southern Tyrol.

Pencil (Lat. peniculus, penicillus). In Geometry, a term of modern origin, applied in the first instance to a system of right lines (rays) drawn through the same point. When all the lines are in the same plane, the system is called a *plane pencil of rays*, and the point its *centre*. A series of planes through the same line is in a similar manner termed a *pencil of planes* having that line for *axis*. Again, in spherical geometry, a series of great circles through the same point is called a *pencil*. The term is also applied to any system of curves of the n^{th} order which intersect in the same n^2 points; the latter are called *the fundamental points*, and constitute the *base* of the *pencil of curves* of the n^{th} order. These fundamental points cannot, of course, all be chosen arbitrarily; in fact, $\frac{n(n+3)}{2}-1$ suffice, in general, to determine the remainder, since all curves passing through these points intersect in

$$\frac{n(n-3)}{2}+1=\frac{(n-1)(n-2)}{2}$$

other fixed points, which together with the chosen ones make up the total number n^2 of intersections of two curves of the n^{th} order. If $U=0$ and $V=0$ represent the equations of any two curves of the n^{th} order, then $U+\lambda V=0$, where λ is a variable parameter, will represent the pencil whose base consists of the n^2 intersections of U and V. Each curve of the pencil is determined by means of a single point in the plane through which it is required to pass. If $a, b, c \ldots$ denote the points forming the base of the pencil, and 1, 2, 3, &c.... points in the plane which serve to individualise the several curves, then the pencil may be represented by the symbol $(a\,b\,c\ \ldots.)$ $[1, 2, 3, \ldots.]$. Thus $(a\,b\,c\,d)$ $[1,2,3,4,]$ represents a pencil of four conics which intersect each other in the points a, b, c, d, and pass respectively through the points 1, 2, 3, 4. This notation was proposed by De Jonquières, in his *Essai sur la Génération des Courbes Géométriques*, Paris 1858—a work well worthy of perusal. The tangents to the several curves of the pencil at any one of the fundamental points constitute a pencil of rays to which, according to the general definition, the pencil of curves is said to be homographic. By the *anharmonic ratio of four curves of the pencil* is meant the anharmonic ratio of such a pencil of four tangents. Two pencils of curves, therefore, of the orders m and n respectively, will be homographic when the corresponding pencils of tangents are so. It can further be easily shown that two such homographic pencils of curves generate, by the intersection of their corresponding elements, a curve of the $(m+n)^{th}$ order passing through the m^2+n^2 fundamental points. And conversely, any curve whatever may be generated by means of two pencils of curves of lower orders. A conic, for instance, is generated by the intersection of corresponding rays of two homographic pencils of rays. For further details on this interesting and important subject, the reader may consult the memoirs of Chasles, Steiner, De Jonquières, Cremona and others in the more recent continental and English journals. We add here only, that the system of surfaces passing through the same *fundamental* (non-plane) *curve* is also called a *pencil of surfaces*, and that the homography of two or more such pencils is susceptible of a definition similar to the one above given.

Pencil, Harmonic. [HARMONIC PENCIL OF RAYS.]

Pencil of Light. In Optics, a bundle of rays or streams of light, which may be either convergent, divergent, or parallel.

Pendant (Lat. pendeo, *I hang*). In Gothic Architecture, an ornamented polygonal piece of stone or timber hanging down from the vault or roof of a building. Of stone pendants some fine examples may be seen in the chapel of Henry VII. at Westminster. In ancient writers the springers of arches, which rest on shafts or corbels, are called *pendants*. Two companion pictures also are called *pendants*.

PENDANT. A long narrow flag borne at the mainmast-head of a ship of war to denote that she is commissioned. Among signals, the pendant is a triangular flag of greater length than width.

Pendentive. In Architecture, the portion of a vault between the arches of a dome, lettered a in the diagram, by which it will be seen that it falls at its superior part into a circle, inscribed in the

square formed on the plan of the four arches. Hence it is obvious that a dome may be formed by means of pendentives over any regular polygon. The pendentives of the Moorish architecture of the Alhambra are cited as models of the employment of this kind of decoration.

Pendulum (Lat. pendulus, *hanging*). Any body vibrating, under the action of gravity, around one of its points (the *point of suspension*) which remains fixed. Each particle of such a body obviously remains on the surface of a sphere whose centre is the point of suspension, and the line joining the point to the centre of suspension describes a cone. On this account such a pendulum is sometimes called a *spherical* or *conical pendulum*, to distinguish it from the ordinary one which vibrates around a fixed horizontal *axis of suspension*, and where each particle describes a circle whose plane is perpendicular to that axis. The theory of the spherical pendulum is far less simple than that of the ordinary one, to which the following remarks will be restricted. The reader will find the theory developed in the works of Laplace, Lagrange, Poisson, and many other writers. The passage

of a pendulum from its greatest *elongation* on one side of the vertical plane through the axis of suspension to its greatest elongation on the other side is called an *oscillation*; the angle subtended at the centre of the circular arc described by each particle during an oscillation is termed the *amplitude*; the *time* required to perform an oscillation is the principal element to be ascertained.

The *simple pendulum*, with whose oscillations those of every other are compared, is purely ideal, and is conceived to consist of a gravitating point, attached by a rigid but weightless rod to the fixed point of suspension. When the amplitude of oscillation is small, the oscillations are, approximately, isochronous, and the time t of oscillation (in seconds) is given by the simple formula:

$$t=\pi\sqrt{\frac{l}{g}}, \text{ where } \pi=3\cdot14129\ldots$$

l is the length of the pendulum (in feet), and g the accelerating force of attraction, i.e. the velocity (in feet) acquired every second by a freely falling body. From this formula we deduce the following laws: 1. At the same distance from the earth's centre, the times of oscillation of two pendulums are directly proportional to the square roots of their lengths; in other words, the number of oscillations made by a pendulum in a given time varies inversely as the square root of its length.

2. At different distances from the earth's centre the times of oscillation, of one and the same pendulum, are inversely proportional to the square root of the accelerating forces; in other words, the force of gravitation varies directly as the square of the number of oscillations per second.

3. The length of the seconds-pendulum, i.e. of the pendulum whose time of oscillation is one second, is directly proportional to the force of gravitation at the place where it oscillates.

Putting $t=1$, the above formula gives $g=\pi^2 l$, whence, from the length of the seconds-pendulum, we can at once calculate the space $\frac{1}{2}g$ described, in one second, by a body falling freely from a state of rest. Thus, the length of the seconds-pendulum at London being 3·2616 feet, according to Captain Kater's experiments, we have

$$\tfrac{1}{2}g=\tfrac{1}{2}(3\cdot31416)^2\times3\cdot2616=16\cdot1 \text{ feet nearly.}$$

In every *compound pendulum*, or heavy body oscillating around a fixed horizontal *axis of suspension*, there is necessarily a certain point at which if all the matter of the pendulum were collected the oscillations would be performed in exactly the same time. This point is the *centre of oscillation*. It is situated in the vertical plane passing through the centre of gravity of the pendulum, and at a distance from the axis of suspension, which is determined by the following formula: Let dm be the element of the mass of the compound pendulum, r its distance from the axis of rotation, and x the distance of the centre of oscillation from the same axis; then

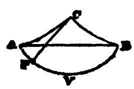
$$x=\int r^2\,dm\div\int r\,dm$$

i.e. the distance of the centre of oscillation from the axis of suspension is equal to the moment of inertia of the oscillating body divided by its moment of rotation. This value of x is the length of the isochronous simple pendulum, and is always to be understood by the term *length of a compound pendulum.*

The centre of oscillation possesses the following very remarkable property, discovered by Huygens. The time of oscillation is unaltered when the centre of oscillation is made the centre of suspension. This property furnishes an easy practical method of determining the centre of oscillation, and thence the length of a compound pendulum. [OSCILLATION.]

The measurement of time by means of the pendulum is said to have first suggested itself to Galileo, on observing the isochronism of the oscillations of a lamp suspended from the roof of the cathedral at Pisa. Huygens, however, was the first to devise mechanism whereby the small isochronous oscillations of a body could be sustained and registered. This invention—the most important that ever was made in reference to practical astronomy—dates from the year 1656.

Huygens' researches on the subject of the oscillations of the pendulum are contained in his admirable work entitled *Horologium Oscillatorium*. He soon found that the oscillations in circular arcs of different amplitudes are not equal, the wider requiring rather a longer time than the narrower; and, with a view to remedy this defect, he undertook to investigate the nature of the curve in which the oscillations would be performed in equal times, whatever might be the extent of the arc described. The curve possessing this remarkable property was found to be the cycloid. [CYCLOID.] The next object was to devise a means of causing a pendulum to vibrate in such a manner that its centre of oscillation shall describe the arc of a cycloid. This was also effected by Huygens by the following construction, which depends on another property of the cycloid, namely, that its evolute is a similar curve: If A C and B C be two semicycloids, or semicycloidal cheeks, each equal to the half of A V B, touching A B in A and B, and meeting one another in C; and if there



be fixed at C a pendulum P, hanging by a thread P C, equal in length to the semicycloid; then P, in its oscillations, will describe the cycloidal arc A V B. Nothing more simple or beautiful in point of theory could be conceived than this construction; but, on attempting to reduce it to practice, it was soon found to possess no advantage, in consequence of the mechanical difficulty of making the cycloidal cheeks with the requisite accuracy, and the

impossibility of obtaining a flexible string of invariable length. Huygens himself showed that the error of a hundredth of an inch in the form of the curve would cause a greater irregularity than a circular vibration of ten or twelve degrees. Accordingly, the use of cycloidal cheeks was abandoned, and the attention of artists directed to the means whereby the oscillations might be confined within very small circular arcs, in which case any inequality in the lengths of the arcs becomes insensible. In clocks of the best construction the arc of vibration is very small; and the pendulum is made very heavy, in order that, by possessing a great momentum, it may be less affected by the imperfections of the machinery.

The oscillations of a pendulum depend upon its length, and the latter, of course, is affected by the temperature of the vibrating body. To counteract the effects of variations in temperature, *compensation pendulums* have been devised; of these the mercurial and gridiron pendulums are best known. The principle in all such contrivances is the same; it consists in combining two substances, whose rates of expansion are unequal, in such a manner that the expansion of the one counteracts that of the other, and keeps the centre of oscillation of the compound body always at the same distance from the axis of suspension. In the volume of the *Cabinet Cyclopædia* devoted to the subject of mechanics, Captain Kater has given an excellent chapter on compensation pendulums.

The determination of the earth's figure and of the force of gravity, as modified by rotation, at its several points, constitutes one of the most elaborate scientific applications of the pendulum. On this subject, however, we must content ourselves with referring the reader to Airy's 'Treatise on the Figure of the Earth' (*Ency. Metro.*). We must notice, too, with equal brevity the ingenious experiment made by Foucault before the Academy of Paris on February 3, 1851, by which the diurnal rotation of the earth was, as it were, rendered visible by the rotation of the plane of oscillation of a pendulum suspended in a peculiar manner from a hard point. The tendency of this plane of oscillation is to remain fixed, so that if the experiment were made at the north pole of the earth, the plane in question would *appear* to rotate with the sun from east to west, and with the same angular velocity. If the experiment were made at the equator there would be no apparent rotation, the pendulum and its plane of rotation being carried bodily with the earth. In other latitudes the apparent rotation would be of the same character as at the poles, but less in velocity. In this case Poinsot has shown very clearly, by his theory of the composition and resolution of rotations, that the apparent velocity of rotation would be equal to that of the earth multiplied by the sine of the latitude. (*Comptes-Rendus*, vols. xxxii. and li.) Upon trial, the experiment is liable to failure from various causes, but principally from the great difficulty of adjusting the suspension so accurately that the vibrations shall continue to be made in a plane; for if the pendulum acquires an elliptic motion, however slight, the greater axis of the ellipse, or line of apsides, immediately begins to revolve from a cause entirely independent of the rotation of the earth, and the two motions cannot easily be distinguished. (*Notices of the Royal Astronomical Society*, vol. xi. p. 199; *Memoirs of Royal Astronomical Society*, vol. xx.)

Penelopê (Gr.). In the Homeric Mythology, the wife of Odysseus and the mother of Telemachus. [Phaëthon.] Parted from Odysseus, who accompanies Agamemnon to the Trojan war [Paris], she determines to remain true to her husband, and repels the importunities of a host of suitors by saying that she will make her choice as soon as she has finished a robe which she is weaving. But the magic web is never ended. During the night Penelopê unweaves all the work of the previous day. Meanwhile Odysseus, after the fall of Ilion, is on his way home; and although on his return to Ithaca he finds her as lovely and as pure as ever, he is bidden, when he seeks an interview with Penelopê, to wait until the evening. Further, he is put to a test. Penelopê waits to see whether he will know his bridal chamber and the beautiful robes which his own hands had wrought. Then from her hands he receives the bow which, like the spear of Achilleus, no hands but his own can wield, and with it he smites the suitors who for twenty years had vainly importuned the pure Penelopê.

The web of Penelopê [Hyperboreans] reappears in the legend of Iolê, for whom Heracles, like Odysseus, weaves a delicate web in the bright spring-time of life. It is the web of morning clouds which the Dawn spreads in the sky for Indra, undone as he leaves her for the garish regions of the midday sky, but reappearing when his course draws to a close—in other words, when the hour is come that Iolê, and Briseis, and Œnônê shall be restored each to the one who has always had her love.

Penestæ (Gr. πενέσται). A name (connected with πένης, *poor*) by which were known the Thessalian serfs, who answered to the Spartan Helots. (Grote's *History of Greece*, vol. ii. p. 374.)

Penetration of Projectiles. [Gunnery; Projectile.]

Penghawar Djambi. The Malay name of the down or soft hair-like scales of a species of Cibotium, which is collected in the islands of the Eastern Archipelago, and used as a styptic. Its action seems to be mechanical.

Penguin. [Aptenodytes.]

Penicillate (Lat. penicillum, *a pencil*). In Zoology, when a part supports one or more small bundles of diverging hairs.

Penicillium (Lat. penicillum). A genus of moulds, chiefly remarkable on account of one of its species, *P. glaucum*, which is one of the commonest of moulds, assuming a variety

of forms from its growing on all kinds of substances. It enters largely into the composition both of yeast and of the Vinegar Plant.

Peninsula (Lat. pæninsula, *almost an island*). A portion of land nearly surrounded by water; as Africa, the Morea, California. Such land was called by the Greeks a Chersonesus (Χερσόνησος); thus the long strip of Thrace that runs along the Hellespont was termed the Thracian Chersonesus, the Crimea being known as the Tauric Chersonese. The term Peninsula is also applied to Spain and Portugal taken together; and the struggle so long maintained between these countries, aided by the British, and the French, at the commencement of the present century, is called the Peninsular War.

Peninvariant. [SEMINVARIANT.]

Penitence or **Penance.** In the Roman Catholic Church, one of the seven sacraments. Priestly orders give the power to confer this sacrament; but, as a matter of discipline, this power is not exercised without authority from the ordinary, either general or special, except in cases of necessity. The terms *penitence* and *penance* are likewise used for the good works commanded by a priest to a penitent to be performed in satisfaction for the sins of which he absolves him. Public penance, in the earlier times of the church, was imposed for great offences committed after baptism. It consisted in exclusion from the church, solitude, prayer, and fasting, and the readmission was only gradual; the penitent being first allowed to approach the doors of the church; then to attend at sermons and readings, but not at prayers; then to pray, kneeling, &c. The time of penance varied according to different usages; St. Basil mentions two years for theft, seven for sensuality, fifteen for adultery, twenty for homicide, and the whole life for apostasy. Public penance for secret sins was generally remitted about the seventh century; and its commutation for the repetition of prayers and bestowing of alms began in the next. These alms were frequently applied by the penitent to the purchase of masses for himself or others. Afterwards the usage of pilgrimage as a mode of penance became general; and, finally, indulgences began to be sold in the twelfth century.

Penitentials. In Ecclesiastical History, collections of canons, regulating the penances to be imposed for sins, and the method of receiving and restoring penitents. Dean Milman (*Latin Christianity*, book iii. ch. v.) regards the penitentials as a check on sacerdotal power, which would otherwise have become as irresponsible as it was despotic.

Penitentiary. A prison in which convicted offenders are placed and subjected to a course of instruction and discipline, with a view to their reformation. [PRISONS.]

Penitentiary, Grand. An officer of the Roman Catholic church, usually a cardinal, appointed by the pope to grant absolution in cases reserved for the papal authority, dispensations for marriage, &c. In like manner, bishops appoint penitentiaries to perform the like office in such cases as are reserved for episcopal absolution. Briefs granted by the grand penitentiary are at the present time entirely gratuitous, and headed with the words *Pro Deo*.

Penitents. A name given in Roman Catholic countries to certain religious fraternities, distinguished by their parti-coloured garments. Of these there were a great variety in France, Spain, Portugal, &c.; but the most extraordinary were the White Penitents, a body of fanatics who appeared in the north of Italy in 1399, clothed in white, and bearing crucifixes, under the guidance of a priest, concerning whom many strange stories were told; among others, that he professed to be the prophet Elias, and that his mission was to announce the immediate destruction of the world. The contagion of this outburst of religious feeling extended to Tuscany, and thence over the whole of Italy; but it lasted only a few months.

Pennatulariæ (Lat. penna, *a feather*). The name of a family of Polypes, of which the sea-pen (*Pennatula*) is the type.

Pennine. A variety of Chlorite found in the Pennine Alps.

Pennite. A variety of Hydrodolomite or carbonate of lime and magnesia, containing a small percentage of oxide of nickel. It is found in the Shetlands at Haroldswick in Unst, and in Swinaness; also at Texas in Pennsylvania.

Pennon (Fr. from Lat. penna, *a feather*). The flag of a knight, in the middle ages, who had not attained the dignity of banneret. It differed from the banner by being pointed at the end.

Penny (Dutch penninck, Ger. pfennig). The twelfth part of a shilling. The penny was at first a silver coin. It contained the 240th part of the pound, and its weight was about twenty-two and a half grains. Till the time of Edward I. the English penny was struck with a cross so deeply sunk in it that it might, on occasion, be easily broken and parted into halves, thence called *halfpenny*; or in four parts, thence called *fourthings* or *farthings*. Edward I. also reduced the weight of the penny to a standard; ordering that it should weigh the twentieth part of an ounce. It afterwards suffered successive diminutions, till, in the reign of Elizabeth, its value was reduced to the sixty-second part of an ounce of silver. This proportion is still observed.

Pennyroyal. One of the species of Mint, called *Mentha Pulegium*, which has properties resembling the other Mints. It has long been valued by country people as a domestic remedy in certain female complaints.

Pennyweight. A weight equal to twenty-four grains, or the twentieth part of an ounce troy. This was the weight of the silver penny in the time of Edward I. [PENNY.]

Pens (Lat. penna, a *feather*). Instruments for writing, usually formed of the quills of the goose, swan, or some other bird. Metallic

pens have long been occasionally employed; but it is only of late years that they have been extensively introduced. They first began to be largely manufactured by Mr. John Perry, of London, who succeeded in giving to his pens a greater degree of softness and elasticity than was possessed by any metallic pens previously in use. They speedily obtained a very extensive sale, and this success brought crowds of rivals into the field; so that metallic pens are now manufactured in vast quantities, and of many forms. In the manufacture of steel pens the best metal, made from Dannemora or hoop (L) iron, is employed. It is laminated into slips about three feet long and four inches broad, of a thickness corresponding to the desired stiffness and flexibility of the pens. These slips are subjected to the action of a stamping press, somewhat similar to that for making buttons. The point destined for the nib is next introduced into an appropriate gauged hole of a little machine, and pressed into the semi-cylindrical shape; where it is also pierced with the middle slit, and the lateral ones, provided the latter are to be given. The pens are now cleaned, by being tossed about among each other, in a tin cylinder (about three feet long and nine inches in diameter), which is suspended at each end upon joints to two cranks, formed one on each of two shafts. The cylinder, by the rotation of a fly-wheel acting upon the crank-shafts, is made to describe such revolutions as agitate the pens in all directions, and polish them by mutual attrition. In the course of four hours several thousand pens may be finished upon this machine. (*Commercial Dictionary*; Ure's *Dictionary of Arts*, &c.)

Pension (Lat. pensio, *a weighing*, hence *a payment*). In the Army, an annual reward for past service, granted to soldiers after doing duty for twenty-one years in the infantry, artillery, or engineers, or twenty-four years in the cavalry. It may, however, be earned by shorter service, if from ill-health, wounds, or reduction of force, a soldier be compelled to quit the service The amount of pension is fixed, according to individual merits, by the commissioners for Chelsea Hospital, and varies from 3*s*. 6*d*. to 1½*d*. a day, the lowest rates being confined to negroes discharged from native regiments serving in the tropics. *In-pensioners* are old soldiers to whom homes are granted in Chelsea and Kilmarnham Hospitals: they forfeit their ordinary pensions, are fed and clothed by government, and have a small allowance as pocket money. The *out-pensioners* draw their pensions, and, living where they will, enjoy their friends' society and devote their time to civil occupations. Many of these men acquire fair incomes; and few are in want of employment, as the habits of order and punctuality acquired in the army qualify them well for situations of trust, as timekeepers, railway guards, instructors of volunteers, &c., while work is provided for a large number by a charitable society formed for the purpose of finding employment for them, and by the Corps of Commissionnaires. The United Kingdom is divided into a large number of districts, each under a staff officer of pensioners, who pays the men within his district, organises them as a veteran company of enrolled pensioners, and would command them if they were called out for garrison duty. These enrolled pensioners are trained for eight days annually, receiving good pay. They number about 12,000 men, and would be a valuable addition to the defensive power of the country in time of emergency.

Pensions for wounds are limited to officers, and are granted as compensation for injuries which, having been sustained in battle, amount to, or equal, the loss of a limb or eye.

Pension to a widow is a posthumous tribute to the worth of a departed officer. The amount varies according to the rank or relative rank of the officer deceased; there being also three rates attached to each rank: first, for the case of an officer slain in battle; second, for that of one dying from illness contracted in the field; third, for one dying under ordinary circumstances. To be eligible for pension, the widow must have been married a year, her age must not have been more than twenty-five years less than her husband's, and the deceased officer must have served ten years on full pay. A widow is disqualified by wealthy circumstances or by immoral character. Remarriage throws the pension into abeyance; but it may be revived in subsequent widowhood. The Secretary of State for War has power to interpret the pension warrant, and can dispense under special circumstances with any portion of the usual requirements. Analogous to the widow's pensions are the compassionate allowances to children of deceased officers. These vary, as in the case of widows, with the rank and cause of death of their parent, and are tenable to the age of twenty-one, unless the orphan be provided for or married earlier.

If an officer leave neither widow nor children, the pension may be granted to his mother or sister, if it can be proved that such relative was dependent on him.

PENSION. In Law, this term has been defined a periodical allowance made to anyone without an equivalent. Pensions given as matters of political favour only were among the commonest instruments of parliamentary government down to the latter part of the last century, but may be said to have disappeared from our usages. The only pensions of this class which are now given are those payable, under Acts of Parliament, to certain ministers of state, &c. on retirement after a number of years' service; and those smaller annual payments, for distinguished services, to literary persons and the like, which are chargeable on the civil list. The pensions to ordinary civil servants of the crown, which, until recently, were earned by a deduction from annual salary, are more commonly styled *superannuation allowances*, and governed by several Acts of Parliament,

of which the last are 20 & 21 Vict. c. 37, 22 Vict. c. 26. Last, and as a separate class, may be mentioned the pensions earned by military and naval services. According to ancient usages, pensioners (as in receipt of public alms) could not sit in the House of Commons: but this rule has been relaxed in some cases of late years by statute, as in the case of diplomatic pensions.

Pension, Naval. An allowance granted to a seaman after long service in the royal navy. Formerly the recipient might be either an in-pensioner, or resident of Greenwich Hospital; or an out-pensioner, receiving an allowance and remaining with his friends. The freedom of the latter life had so much to recommend it, as compared with the corrupt monasticism of the former, that by a change made in 1865 the in-pension was prospectively abolished. Other naval pensions are those for wounds granted to commissioned and warrant officers; good-service pensions, which are extra allowances to certain officers; and pensions to the widows of commissioned and warrant officers. Certain small pensions are granted by the Trinity House to deserving sailors of the mercantile marine. Naval pensions, like army pensions, are paid by the military staff officers of pensioners, and generally the pensions of the navy follow the rules of army pensions, the lords of the admiralty being substituted as managers for the Secretary of State for War.

Pensionary, the Grand, of Holland. This title was given to the prime minister of the states of the province of Holland, who proposed the measures to be discussed in the assembly of the states, transacted business with foreign ministers, and fulfilled other important functions. His term of service was five years, and he was capable of re-election.

Pensioner. Literally, one who receives a pension or allowance. At the universities of Cambridge and Dublin, this term is applied to those students who live at their own expense, i.e. without any support from the foundations of the respective colleges. In this sense it is synonymous with commoner at Oxford.

Pentacrinites (Gr. πέντε, *five*, and κρίνον, *lily*). The name of a tribe of Echinoderms, comprehending those in which the animal consists of an angular, jointed, flexible column, fixed at the base, and supporting on its free extremity a concave disc or body, terminating in five dichotomising, jointed, semicylindrical arms. Most of the species and genera of this tribe are extinct.

Pentagon (Gr. πεντάγωνος). In elementary Geometry, a plane figure having five corners and five sides. A *regular* pentagon is equiangular and equilateral. The inscription of a regular pentagon in a circle is one of the gems of Euclid's fourth book, and is made to depend upon the *golden section* of a line; that is to say, upon its division into two segments such that the rectangle under the smaller and the whole line is equal to the square on the greater. The area of a regular pentagon is 1·7204774 . . . times that of the square on one of its sides.

Pentagraph. [PANTAGRAPH.]

Pentamerans (Gr. πέντε, and μηρός, *a joint*). The name of a section of Coleopterous insects, including those which have five joints on the tarsus of each leg.

Pentameter (Gr. πεντάμετρος, *of five measures or feet*). A species of verse consisting of five feet or measures (whence the name), and which when subjoined to an hexameter verse made up an *elegiac* couplet.

The scheme of the pentameter is as follows:—

–⏑⏑ | –⏑⏑ | – | –⏑⏑ | –⏑⏑ | – |

It must be observed, that the cæsural pause at the third foot must always terminate a word; and, as a general rule, the last word of the verse must consist of two syllables, although a quadrisyllable, especially in proper names, is sometimes admitted.

The first Greek elegiac writers were Callinus and Tyrtæus, who were followed by Mimnermus, Theognis, and Solon, in their own country; and by Catullus, Propertius, Tibullus, and Ovid in Rome. The variety of themes sung by these different writers proves the capacity of this measure for adaptation to every subject, whether mournful, as the term *elegiac* would imply; or political and warlike, like the strains of Tyrtæus and Callinus; or erotic, like those of Propertius, Tibullus, and Ovid; or historical and mythological, like the *Fasti* of the last. The hexameter and pentameter distich is described in the following lines of Schiller:—

Im Hexameter steigt des Springquells flüssige Säule:
Im Pentameter drauf fällt sie melodisch herab;

thus rendered by Coleridge, who was long considered as the original author:—

In the hexameter rises the fountain's silvery column:
In the pentameter aye falling in melody back.

Every page of Ovid's *Heroïdes*, or *Tristia*, illustrates the manner in which the hexameter breaks and falls back in the pentameter; indeed, the secret genius of the metre appears to consist in this play.

Besides this peculiarity in the pentameter, grammarians have pointed out several others, of which perhaps the most important is the axiom that although either a spondee or a dactyl may be used at pleasure in the first two feet of the verse, a dactyl should be preferred to a spondee whenever practicable. [HEXAMETER.]

Pentapolis (Gr. *with five cities*). A name given by the ancient Greeks to certain countries which were remarkable for having five distinguished cities: thus there was the Pentapolis of Libya, Italy, and Asia Minor; but the most celebrated was the Pentapolis Cyrenaica, of which the five cities were Berenice, Arsinoë, Ptolemais, Cyrene, and Apollonia.

Pentaptera (Gr. πέντε, *five*, and πτερόν, *a wing*). *P. glabra* is a large smooth-barked tree, common in the teak forests of Pegu, and yields an excellent dark-coloured timber, used for mast-pieces, spars, and other shipbuilding purposes. In Canara, the natives obtain a

kind of lime by calcining the bark and wood, which they prefer to ordinary cane for chewing with their betel-nut.

Pentastemon (Gr. πέντε, and στήμων, *a stamen*). A popular genus of garden perennials belonging to the *Scrophulariaceæ*. The flowers are tubular, borne in clustered panicles, and various in colour.

Pentateuch (Gr. πεντάτευχος, from πέντε, and τεῦχος, *an instrument*, hence *a book*). A name given to denote collectively the five books commonly known as the books of Moses: viz. Genesis, Exodus, Leviticus, Numbers, and Deuteronomy. 1. The book of *Genesis* (Gr. *a creation*) gives an account of the creation of the world and of man; of the antediluvian patriarchs, and of the flood; and the history of the Jewish patriarchs, Abraham, Isaac, and Jacob, down to Joseph. 2. The book of *Exodus* (Gr. ἔξοδος, *a going out*) narrates the fortunes of the descendants of Abraham after their migration to Egypt; the birth of Moses, and his endeavours to emancipate the Jewish nation from Egyptian bondage; their escape from Egypt; their journey through the wilderness; and the delivery of the law to Moses. 3. The book of *Leviticus* consists chiefly of the law and ordinances of the Jewish priesthood, as to the different kinds of sacrifices to be offered up; the duties of masters towards their slaves; regulations as to marriage, &c. [Levites.] 4. The book of *Numbers* (so called from its giving an account of the numbering of the people) contains besides, an enumeration of many civil and ceremonial ordinances; and embraces a period of thirty-eight years, chiefly relating to the captivity and the wilderness. 5. The book of *Deuteronomy* (Gr. δεύτερος, *second*, and νόμος, *law*) contains chiefly (as the term implies) a condensed summary of the laws and ordinances delivered in the three preceding books. On the date and authorship of these books there is still much difference of opinion. Bishop Colenso (*Pentateuch and Book of Joshua critically examined*) maintains that no part of them was thrown into the form in which we have the books, before the time of Saul or David, and that the book of Deuteronomy was written in or about the time of Josiah. Opinions differing more or less from those of Dr. Colenso, are advanced by Dean Milman, *History of the Jews*, Ewald, *Geschichte des Volkes Israel*, Hengstenberg *On the Pentateuch*, &c.; to which, with almost all other works relating to the literature of the subject, references may be found in the volumes of the bishop of Natal.

Of the two ancient copies of the Pentateuch, the one written in Samaritan or Phœnician characters, the other in Chaldean, the latter was adopted by the Jews, in preference to the former, after their return from Babylon.

Pentathionic Acid. An unstable oxygen compound of sulphur. Its formula is S_5O_5, HO.

Pentathlon (Gr. from πέντε, and ἆθλος, *a contest*). A general appellation given by the Greeks to their five chief bodily exercises; viz. running, leaping, throwing the quoit or discus, hurling the javelin, and wrestling. These five exercises were termed *Quinquertium* by the Romans.

Penteconteri. [Trireme.]

Pentecost (Gr. πεντηκοστός, *fiftieth*). A Jewish festival; so called because it was observed on the *fiftieth* day after the feast of unleavened bread; i.e. the fifteenth of the month Nisan, and next day after the feast of the Passover. Being celebrated seven weeks after the Passover, it also obtained the name of the Feast of Weeks. It occurred about the beginning of the harvest, and seems to have been instituted as an acknowledgement of the goodness of God in giving the fruits of the earth. It was also considered in later times as commemorating the giving of the law on Mount Sinai, according to the construction put on Exod. xix. The narrative of the descent of the fiery tongues upon the apostles on the same day, as given in Acts ii., has caused its observance to be continued among Christians. In England it is known by the name of Whit Sunday; and in Germany by that of *Pfingsten*.

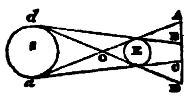
Pentelasmidæ (Gr. πέντε, and ἔλασμα, *a metal plate*). The family of Pedunculate Cirripeds of which the common barnacle (*Pentelasmis*) is the type. The principal organs of the body are protected by five shelly plates.

Pentheus (Gr.). In the Theban Mythology, a son of Agavê daughter of Cadmus. [Europa.] During his reign, it is said that Dionysus returned from his wanderings in Egypt and other Eastern countries, bringing with him the frenzied orgiastic rites hitherto unknown in the Achæan land. Pentheus resisted their introduction; but the fury of the women who had been fascinated by Dionysus was not to be withstood. Having climbed a pine-tree to see what the women did in their orgies, he was discovered, pulled down, and torn in pieces, his mother Agavê being the first to lay hands on her son. The tale of Pentheus is one of many which indicate the resistance made to the changes in the old Hellenic worship by new rites brought in from Thrace and other countries. (Grote, *History of Greece*, i. 38–50.)

Penult or **Penultima** (Lat. pænè ultima, *almost last*). In Grammar and Prosody, the last syllable of a word but one.

Penumbra (Lat. pæne, *almost*, and umbra, *shadow*). An imperfect shadow. In an eclipse of the moon, the penumbra of the earth is occasioned by the apparent magnitude of the sun's disc, and covers that portion of space behind the earth within which a body will be illuminated by a part only, and not by the whole of the disc of the sun. It is thus distinguished from the *umbra*, or perfect shadow, which is the conical space within which no part of the disc of the sun is visible. Let S be the sun, E the earth, A D the orbit of the moon; and let *a* A, *a* C, *d* B, *d* D, be tangents to S and E. As soon as the moon passes the point A, a portion of the sun's disc at *a* will be intercepted,

and the visible portion will become less and less until the moon reaches B, where total darkness begins. From A to B, therefore, the moon is in the penumbra. The umbra extends from B to C. When the moon passes C, it will again receive the light from the border of the solar disc at *a*, and will be in the penumbra from C to D. The whole penumbra thus forms a cone, of which the apex is at O, and the angle at the apex equal to A O D. As the obscurity becomes greater in proportion as more of the solar disc is concealed, and insensibly merges into total shade, it is extremely difficult in eclipses of the moon to determine by observation the exact time at which the moon's limb passes the point B or C, and the eclipse begins or ends.



In solar eclipses those parts of the earth which are covered by the penumbra of the moon are only partially deprived of the sun's light. Let E be the moon, and A D part of the earth's orbit. To a spectator on the earth, placed between A and B, a part of the sun's disc is concealed, and the sun is partially eclipsed. The limits are calculated from the known magnitudes and positions of the sun and moon, and their respective distances from the earth. [Eclipse.]

Penumbra. In Painting, &c., the boundary of shade and light where the one blends with the other, the gradation being almost imperceptible; called also *half-tint*.

Peonage (Span. peonaje). A peculiar form of servitude which existed in Mexico after the Mexican conquest. The Spaniards constrained the Aztec population to work for certain times in the mines; this service was called *mita*. The obligation was abandoned before the War of Independence. But there still remained, it appears, the contingency of peonage, confined, however, to criminals and debtors. As far as the latter were concerned, peonage ceased after the independence of the country was secured. It is stated, however, that one of the acts of the new empire has been a revival of peonage, perhaps in its earlier form of a corvée or compulsory labour for public purposes, and the change has excited one of the present complaints uttered against the new régime, as showing a tendency towards establishing a form of slavery.

Peony. [Pæonia.]

Peperino. An Italian technical name for a particular kind of volcanic rock, formed by the cementing together of volcanic sand and ashes. Many of these curious compound rocks, possessing valuable properties, have been met with in volcanic countries. They almost all form admirable natural cement stones, and consist, for the most part, of the materials of felspar combined with a certain proportion of carbonate of lime.

Peplolite (Gr. πέπλος, *a covering*; λίθος, *stone*). A pseudomorphous mineral, after Iolite, from Ramsberg in Sweden.

Peplus (Gr. πέπλος). An upper garment anciently worn by the Greek, and especially by the Athenian, females: it was without sleeves, and fastened by a clasp on the arm or shoulder. The celebrated peplus of Athena was carried every year, in the Panathenaic processions, from the Ceramicus to the Parthenon, where it was offered to the goddess. The antiquity of this kind of ceremony is evinced by the passage in the *Iliad* (book vi.) where the Trojan women offer a similar robe. With this robe or peplus may be compared the hangings woven by the Jewish women for the Ashera. [Panathenæa; Phallus.]

Pepo (Lat.; Gr. πέπων—lit. *ripe—a gourd*). In Botany, a one-celled, many-seeded inferior fruit, with parietal placentæ, and a pulpy interior, as the Melon, the Gourd, &c.

Pepper (Lat. piper, Gr. πέπερι). The Pepper of commerce consists of the fruits of *Piper nigrum*, which, as prepared with or without their skin, form respectively black and white pepper. Other sorts of *Piper* possess properties for which they are valued in medicine. The name of Pepper is also given to several other vegetable products. Thus Bell Pepper, Bird Pepper, Bonnet Pepper, and Guinea Pepper, are various kinds of *Capsicum*, the fruits of which dried and ground yield Cayenne Pepper: African Pepper and Ethiopian Pepper are yielded by *Habzelia*; Jamaica Pepper is the Allspice, *Eugenia pimenta*; *Malaguetta* Pepper is the produce of an *Amomum*; and Japanese Pepper is *Xanthoxylon piperitum*. [Pimento; Piper; Piperaceæ.]

Pepper-brand. Another name for Bunt. An affection of corn plants attributable to the presence of a microscopic fungus, called *Tilletia caries*. The wheat crop often suffers much from this parasite.

Pepper-dulse. The *Laurencia pinnatifida*, an alga which is sometimes eaten in salads, but is of inferior quality.

Pepper-pot. The man-dram, a West Indian appetising preparation of Capsicum and other ingredients.

Peppermint. The common name for *Mentha piperita*, a medicinal herb, which on distillation yields the Oil of Peppermint of the shops. [Mentha; Mint.] This oil and the preparations made from it are largely used as aromatics, carminatives, and stimulants; while from its powerful flavour it is often used to cover the taste of nauseous drugs.

Pepsine (Gr. πέψις, *digestion*). A peculiar animal principle, contained, but only in very minute quantity, in the gastric juice, and which, in conjunction with acid matter, also present in that secretion, confers upon it its solvent or digestive powers in regard to certain components of the food, and more especially in respect to the nitrogeniferous or plastic nutriment, such as albumen, fibrin, casein, and their modifications. It is especially characterised by its power of coagulating milk [Rennet], and afterwards acting upon and dissolving the coagulum. It has no such

solvent power over fatty or amylaceous matters. Various means of isolating this principle have been suggested, but none of them very satisfactory. Certain preparations represented as containing pepsine (such as *pepsine wine*, &c.) have been supposed to be medicinally useful, as promoters of digestion; but, even if they do contain pepsine, their therapeutic powers are very doubtful. According to Schmidt, by neutralising the gastric juice (obtained in this case from a woman suffering under a gastric fistula) with chalk, filtering, concentrating it by careful evaporation, and then adding alcohol, the pepsine is thrown down in white flakes, which are soluble in water and weak alcohol, but insoluble in pure alcohol, and which, if heated above 150°, lose all their peculiar properties.

Peptic. Relating to digestion. [DYSPEPSIA.]

Perambulator (Lat. ambulo, *I walk*). A machine for measuring distances on roads; also called ODOMETER and *surveying wheel*. Machines of various sorts have been constructed for this purpose, both in ancient and modern times. One is described by Vitruvius, in his work *De Architecturâ*, lib. x. c. xiv. The machine commonly employed consists of a wheel, to which a sort of double pole is attached, carrying an apparatus of clockwork, which is set in motion by the revolution of the wheel, and shows the number of miles, furlongs, &c., passed over by an index and dial. The apparatus may be drawn along by a person on foot, or by a carriage, to which it is more usually attached. For the sake of facility in reckoning, the circumference of the measuring wheel is made equal to an aliquot part of a mile; usually half a pole, or ninety-nine inches. (*Repository of Arts*, vi. 249.)

(Lat. perceptio). In Mental Philosophy, that power, act, or state of the mind, which has a conscious reference to external objects. Various theories of perception have arisen among philosophers, differing as this reference is supposed to be more or less immediate, or as the objects to which it refers are conceived to possess an independent reality or not. These theories are designated by the terms *idealism* and *realism*, which latter is subdivided into natural or positive, and relative or negative realism. The best known system of idealism is that of Bishop Berkeley. [IDEALISM.]

According to the scheme of negative or relative realism, all that we can know of an object is the feeling which it excites in our minds. The cause of this feeling we necessarily judge to be something external to ourselves; but what it is in itself we have no means of knowing. This is the view adopted by the great majority of philosophers, down to Kant and Brown.

The theory of natural realism is the one supported by Dr. Reid under the name of the *common-sense* system. This philosopher conceives the object in perception to be in some way *immediately* present to our consciousness its qualities are not merely felt by us, but discovered *in it*. We derive a certain sensation from the whiteness or roundness of an object; but it is the object itself and not our minds that are white or round. This doctrine, which was also that of the ancient Stoics, and expressed by them in nearly the same words as those used by Reid, is in fact rather a statement than an explanation of the problem. (Bain, *The Senses and the Will.*)

Perch (Lat. perca, Gr. πέρκη). The *Perca fluviatilis*, a river fish well known to anglers, and of which several allied species are to be found throughout all the northern countries of Europe; the family is more widely dispersed.

PERCH (Fr. perche, Lat. pertica, *a rod*). In Land Measure, the fortieth part of a rood, or thirty and a quarter square yards. Perch is also sometimes used as a denomination of long measure, when it signifies the same thing as a rod or pole, being five and a half yards, or sixteen and a half feet.

Perchers (Lat. pertica, *a rod*). The name of an order of birds, including the *Scansores* and *Passeres* of Cuvier. [INSESSORES.]

Perchloric Acid. When sulphuric acid is poured upon chlorate of potash, gaseous oxide of chlorine is evolved, and the saline matter which remains is a mixture of bisulphate of potash and perchlorate of potash; by washing it with cold water the former salt is dissolved, but the latter remains in the form of a white powder. When this is mixed with three times its weight of concentrated sulphuric acid, and heat applied, white vapours rise, which condense as a colourless crystalline substance in the receiver. By rectification at 230° Fahr. this substance yields pure perchloric acid, which is at ordinary temperatures a heavy colourless volatile liquid which does not solidify at −30° Fahr. Perchloric acid readily gives up its oxygen to organic substances. Dropped upon charcoal, ether, or alcohol, it explodes with intense violence. Its formula is ClO_7,HO.

Percoids (Lat. perca, *a perch*). The name of the tribe of Acanthopterygian fishes of which the genus *Perca* is the type.

Percussion (Lat. percussio, from percutio, *I strike*). In Mechanics, the collision or striking of one body against another. The subject has been treated by Poinsot, with his customary ability and clearness, in Liouville's *Journal*, t. ii. 1857. A translation of this memoir will be found in the *Phil. Mag.* vol. xv. 1858, and many of the theorems which it contains are given by Prof. Price in his *Infinitesimal Calculus*, vol. iv.

PERCUSSION. In Medical language, the striking or ing upon any part of the surface of the body, with a view of ascertaining the condition of the subjacent parts by the sound so produced. It is a valuable mode of exploration in some diseases of the chest. Attention was first called to this mode of diagnosis in 1761, by Dr. Avenbrugger, of Vienna: his work was translated into French in 1808, by Corvisart, and the subject was further illustrated in 1816 by the celebrated work of Laennec on *Auscultation*.

Though the great value of this mode of exploration consists in its application to cases of chest affection, it is also of much assistance in abdominal disease, and more especially when tumours are present. It not only assists us to define their extent, but by affording a criterion of their relative position with the intestines, it often enables us more accurately to determine the exact organ or structure involved.

Percussion Cap. The composition now used for the service caps consists of—

Fulminate of mercury	. .	6 parts
Chlorate of potash	. .	6 „
Antimony	. . . . .	4 „

This is pressed into the caps, and afterwards varnished to render it waterproof. The varnish is not mixed with the composition. [CAP, PERCUSSION.]

Percussion, Centre of. That point in a solid body revolving on an axis at which, if an obstacle were applied sufficient to resist the rotation of the system, no motion would be communicated to the axis; or, which is the same thing, if the axis were not fixed the system would acquire no tendency to revolve through the shock applied at that point. The centre of percussion is in the straight line passing through the centre of gravity perpendicular to the axis; and its distance from the axis is expressed by the formula

$$\int r^2 d\,m \div \int r\,d\,m,$$

where $d\,m$ is the element of mass, and r the distance of $d\,m$ from the axis. Poinsot, in his investigation on Percussion, defines this centre somewhat differently.

Percussion of Fluids. [HYDRODYNAMICS.]

Percussion Fuse. In Artillery, a fuse which is prepared to act by the shock of the discharge, but put in action by the second shock on striking the object.

Percylite. A chloride of lead and copper occurring in minute sky-blue cubes at La Sonora in Mexico; and named after Dr. John Percy.

Perdix (Gr. and Lat.). The genus of Gallinaceous birds to which the partridges belong. Many species are known.

Peregrine Falcon (Lat. peregrinus, *wandering*, from the manner of its flight). A species of long-tailed falcons, much used for sport in the middle ages. The changes which the young of the Peregrine Falcon, like that of most Raptorial birds, undergoes, have caused much confusion as to the nomenclature of the genus. Thus the Stone Falcon (*Falco lithofalco*) forms only one phase of the developement of the Peregrine Falcon.

Peremptory (Lat. peremptorius, from perimo, *I cut off*). In Law, certain proceedings are so called which are of a final and arbitrary nature, admitting of no answer but obedience: such as a *peremptory* challenge to jurymen, without cause assigned; a *peremptory* mandamus, issued where a first mandamus has been disobeyed without sufficient cause; a *peremptory* undertaking to try at the next sessions or assizes where a defendant has been allowed to put off trial as matter of indulgence; and so forth.

Perennials (Lat. perennis, *lasting throughout the year*). In Botany, those plants whose roots remain alive more years than two, but whose stems flower and perish annually. Gardeners generally call them herbaceous plants. They differ from annuals and biennials not only in the time of their duration, but also in this, that the two former perish as soon as they have flowered, the act of reproduction exhausting their vital energies. Notwithstanding this distinction, it is not at all times easy to say whether a plant is a perennial or not; as, for instance, in the *Agave americana*, commonly called the American Aloe This plant is herbaceous, and lives for many years; but when it flowers it dies: so that in one respect it is annual, its whole life being regarded as only one season of growth; in another respect it is truly perennial. Such perennials are called by De Candolle *monocarpic*.

Perennibranchiates (Lat. perennis, *continual*; branchia, *gills*). The name of that division of Batrachian reptiles including the species which preserve the external branchiæ or branchial apertures throughout life; as the Siren, Proteus, and Menopome.

Pereskia (after N. F. Peireskius). A genus of the Cactus family, distinguished from others by its fully developed leaves, and hard woody stems. *P. aculeata* is called the Barbados Gooseberry, its yellow fruits being edible and pleasantly tasted, and used in the West Indies for making preserves. Another species, *P. Bleo*, bears handsome rose-coloured flowers, and its leaves are eaten as salad in Panama.

Perfect Cadence. In Music. [CADENCE.]

Perfect Number. In Arithmetic, a number equal to the sum of all its divisors. Thus 6 is a perfect number, for its divisors are 1, 2, and 3, and $1+2+3=6$. In like manner, 28 is a perfect number, for its divisors are 1, 2, 4, 7, 14; the sum of which $=28$. In general, every number of the form $2^{n-1}(2^n-1)$, the latter factor being a prime, is a perfect number, the sum of its divisors being equal to the number itself. Perfect numbers are opposed to *imperfect* ones, which latter are divided into two classes, *abundant* and *deficient*, according as the sum of the divisors exceeds or is exceeded by the number itself.

Perfect Tense. That form of the verb marked in English by the auxiliary *have*, which designates an action finished at the time when we speak of it.

Perfectibility (Lat. perfectus, part. of perficio, *I complete*). The capability of arriving at perfection. This word, which is entirely modern, and scarcely as yet admitted in our language on classical English authority, is commonly used in reasoning on the social condition of mankind. The theory of the indefinite perfectibility of the human faculties, which constitutes the basis of many modern systems, is perhaps nowhere so plainly deve-

loped as in the Preface to the *Tableau Historique de l'Entendement Humain* of Condorcet.

Perfecting. In Printing, taking the impression from the second form of a sheet, called also the *reiteration* or *ret*.

Perfoliate (Lat. per, *through*, and folium, *a leaf*). In Botany, when the bases of two opposite leaves are so united that the stem appears to pass through the substance of the leaf itself.

Perfume (Fr. parfum, Lat. fumus, *smoke*). A term used to denote the volatile effluvia from any body affecting the organ of smelling, or the substance emitting those effluvia. Perfumes were in general use among the ancients (*Quart. Rev.* vol. xxiii.); and in France, Germany, Spain, and Portugal, and, though not to so considerable an extent, in England, they are regarded almost as necessaries. In general they are made of musk, ambergris, civet, rose and cedar woods, orange flowers, jasmines, jonquils, tuberoses, and other odoriferous flowers. Aromatic drugs, such as storax, frankincense, benzoin, cloves, &c. &c., enter into the composition of a perfume; and many perfumes are composed of aromatic herbs or leaves, as lavender, marjoram, sage, thyme, &c. &c. (See the article 'Perfumery' in Ure's *Dict. of Arts &c.*) [ODOURS OF FLOWERS.]

Pergameneous (Lat. pergamena, *parchment*). In Entomology, when a part consists of a thin, tough, semitransparent substance somewhat resembling parchment.

Pergula (Lat.). In Ancient Architecture, probably a kind of booth or small house, so constructed that those who passed by might easily look into it, and hence used by those who wished to attract notice, as painters, teachers of philosophy and grammar, &c. By Winckelman it is thought to be an arbour in a garden, or a terrace overhanging a garden.

Pergunnah (Hind. pargana). In British India, the designation of a district comprising several villages, and forming a subdivision of a zillah.

Periagua. A large canoe used in the Pacific, and composed of the trunks of two trees.

Perianth (Gr. περί, *around*, and ἄνθος, *a flower*). In Botany, a calyx and corolla, the limits of which are undefined, so that the parts cannot be satisfactorily distinguished from each other; as in many Monocotyledonous plants, e.g. the Tulip.

Peribolos (Gr. from περί, *around*, and βάλλω, *I cast*). In Architecture, a court or enclosure of a temple surrounded by a wall. In a peribolos at Palmyra, the temple is surrounded by a wall with two rows of interior columns, each side of which is from seven hundred to eight hundred feet long. (Wood, *Ruins of Palmyra.*)

Pericarditis (Gr. περί, and καρδία, *the heart*). Inflammation of the pericardium.

Pericardium (Gr. περικάρδιος). The membranous sac which surrounds the heart.

Pericarp (Gr. περί, and καρπός, *fruit*). In Botany, every part of a ripe fruit on the outer side of the placenta.

Perichætial (Gr. περί, and χαίτη, *hair*). In Botany, the leaves situated at the base of the setæ of mosses.

Periclase (Gr. περί, and κλάσις, *cleavage*). A native magnesia with from 5 to 8 per cent. of protoxide of iron, found at Monte Somma near Naples, in ejected masses of white limestone. It occurs in octahedrons and in grains of a dark green colour. The name has reference to the cleavages at the angles.

Pericline (Gr. περικλινής, *sloping on all sides*). A variety of Albite or Soda-Felspar in which a portion of the soda is replaced by potash. It is found at St. Gotthard in Switzerland in large distinct crystals; at Zöblitz in Saxony, and in the Tyrol.

Pericope (Gr. περικοπή, *a section*, from κόπτω, *I cut*). A word used by theologians to signify a passage of the Bible extracted for the purpose of reading in the communion service and other portions of the ritual; or as a text for a sermon or homily.

Pericranium (Gr. περικράνιος, *passing round the cranium or skull*). The membrane of the bones of the skull.

Peridiola (Gr. περιδέω, *I bind round*). The membrane by which the sporules of Algaceous plants are immediately covered.

Peridium (Gr. περιδέω, *I bind round*). In Botany, a term used for the outer coat or coats immediately enveloping the sporules, in some fungi.

Peridot (Arab. feridet, *a precious stone*). A name for CHRYSOLITE.

Peridrome (Gr. περίδρομος, from περί, and δρόμος). In Architecture, the space in a peripteral temple between the walls of the cella and the columns. The term may be applied to any gallery of communication round an edifice.

Perigee (Gr. περίγειος, from περί, and γῆ, *the earth*). In Astronomy, that point of the moon's orbit which is nearest to the earth. Anciently the term *perigee* was applied to the orbits of the sun and planets, as well as the moon, because they were supposed to circulate round the earth. Since the true centre of motion has been discovered, the term *perihelion* is used to denote the corresponding points.

Perigone (Gr. περί, and γίγνομαι, *I grow*). A synonym of the word *perianth*; but frequently applied in the case of those plants in which the parts of the flower are all herbaceous and not coloured, as in the Docks.

Perigynium (Gr. περί, and γυνή, *a female*). The urceolate body formed in the genus *Carex* by two bracts, which become confluent at their edges, and enclose the pistil, leaving a passage for the stigmas at their apex. The term is also used occasionally to denote the organ commonly called the disc.

Perigynous (Gr. περί, and γυνή). In Botany, a term applied to stamens or petals which originate from the sides of a calyx.

Perihelion (Gr. περί, and ἥλιος, *the sun*). In Astronomy, the point in the orbit of a planet or comet which is nearest the sun. It is the extremity of the major axis of the

orbit nearest to that focus in which the sun is placed; and its position, or longitude, is one of the elements by which the orbit is determined. [PLANET.]

Perilla. The name of a genus of *Labiatæ*, chiefly interesting from its containing a species, *P. nankinensis*, with deep purple leaves, which is much used in the planting of modern summer flower gardens, leaf-colour being largely employed to produce pictorial effects.

Perilymph (a word coined from Gr. περί, and Lat. lympha, *water*). The fluid between the membranous and osseous labyrinth of the ear, or that in which the membranous labyrinth is suspended.

Perimeter (Gr. περίμετρος, from περί, and μέτρον, *measure*). In Geometry, the circuit or boundary of any plane figure. In round figures it is equivalent to circumference or periphery; but the term is more frequently applied to figures bounded by straight lines.

Period (Gr. περίοδος). In Astronomy and Chronology, this word denotes an interval of time at the end of which the same phenomenon again takes place. The period, or *periodic time*, of a planet is the time in which it performs a revolution in its orbit. For chronological periods, see CYCLE. The term is also used in Arithmetic, to denote the recurrence of a series of digits or numbers in the same order as in circulating decimal fractions.

PERIOD. In Rhetoric, strictly a sentence so framed that the grammatical construction will not admit a close, and the meaning remains suspended, until the end of it. A sentence in which the sense would permit of a stop before its completion is, in this sense, not a period. The Greek and Latin languages were much more periodic than most modern tongues; i.e. they admitted of the construction of sentences so that a single grammatical connection should run through a great series of words, while a similar series, in a modern language, would be so arranged as to form several distinct grammatical wholes.

Period, The Julian. [JULIAN PERIOD.]

Periodic Acid. An acid analogous in composition to the *perchloric*, consisting of 1 atom of iodine, 7 of oxygen, and 1 of water (IO_7, HO).

Periodic Function. In Mathematics, a function whose values recur as the value of the independent continuously increases. The difference between two successive values of the independent variable corresponding to equal values of the function is called the *period*. The trigonometrical functions are periodic, their period being 2π. Exponential functions also possess the property of *periodicity*, but their period is imaginary, being equal to $2\pi\sqrt{-1}$. Elliptic functions, since they include both trigonometrical and exponential ones, are *doubly periodic*. The term *periodic* is applied to ordinary and to continued fractions, as well as to series, in a manner which will be best understood by referring to the respective terms.

Periodicals. In Literature, strictly, publications continued in numbers, appearing at regular intervals. But papers appearing at uncertain intervals (especially in Germany) are often comprehended under this general name. The first periodical in the character of a review was the *Journal des Savans*, begun in 1663.

Periœci (Gr. περίοικοι, from περί, and οἰκέω, *I dwell*). In Geography, those inhabitants of the globe who live under the same parallel of latitude, but on opposite meridians; that is, in places which have the same latitude, but differ in longitude by 180°. They have their spring, summer, winter, and autumn in the same months of the year; but when it is noon with the one it is midnight with the other.

In Greek history, the Periœci were the freemen or citizens of the hundred townships of Laconia, as distinguished from the ruling class of Spartan citizens. [SPARTIATÆ.]

Periosteum (Gr. περιόστεον, from περί, and ὀστέον, *a bone*). The membrane which invests the bones. It is of a fibrous texture, and vascular.

Periostracum (Gr. περί, and ὄστρακον, *a shell*). The layer of animal substance, or cuticle, which covers the outer surface of shells, and which the French conchologists term *drap marin*.

Periotic Bones (Gr. περί, and οὖς, ὠτός, *the ear*). The bones which surround the internal ear, or *labyrinth*. The bone which immediately invests it is the *petrosal* or *ear-capsule*: this is surrounded by the exoccipital, paroccipital, alisphenoid, mastoid, basioccipital, tympanic, and squamosal, or by some of them. The cavity which they form for the ear-capsule is the *otocrane*: it is serially homologous with the *orbit*.

Peripatetics. A name given to that school of ancient philosophers which derived its origin from Aristotle, who instructed them in a περίπατος, or covered walk, of the Lyceum at Athens. The immediate successors of Aristotle in the peripatetic doctrine were Theophrastus, Eudemus the Rhodian (from whom is derived the title of the Eudemian Ethics), Dicæarchus of Messana, Aristoxenus of Tarentum, and Strato of Lampsacus; among the later Peripatetics are preserved the names of Glycon of Troas, Hieronymus of Rhodes, &c. It would be unreasonable to expect that so elaborate a system as that of Aristotle should have received any important addition to its leading doctrines at the hands of his followers. They contented themselves either with defending and interpreting their master's doctrines, or with applying his method to the explanation of natural philosophy. Under their hands his system seems to have degenerated into a species of empirical materialism, a scheme as widely at variance with his genuine doctrines as was the dry scholastic formalism which in the dark ages also passed for his philosophy. (For notices of the later Peripatetics, see Cicero, *Acad. Quæst.*, and *De Finibus*, c. v.; Lactant. *De Irâ Dei*, c. x.; Plutarch, *De Sol.rtiâ*, &c.) The Peripatetic school produced no men of

note after its great founder, which is attributable to the current of free speculation being shackled by the authority of Aristotle, whose dogmas it was content to illustrate without daring ever to impugn them; and in this respect its spirit was remarkably contrasted with the scepticism of the new Academy. (Ritter's *History of Ancient Philosophy*, book ix. ch. i.) [ARISTOTELIAN PHILOSOPHY.]

Peripeteia (Gr. *a sudden reversing*). According to Aristotle (*Poet.* ii. 1), a condition or circumstance of the drama, being a change of fortune from happiness to misery, or the reverse, which takes place in the situation of the principal personage. [CATASTROPHE; DRAMA.]

Periphery (Gr. περιφέρεια, *a circumference*). In Geometry, the contour or boundary of a closed figure; ordinarily it is synonymous with perimeter, and, in the case of the circle, with circumference.

Periphrasis (Gr.). In Rhetoric, the use of several words to express the sense of one, or of a more involved and prolix form of expression to convey a meaning which might be adequately denoted by a shorter phrase.

Periplanetum. In Astronomy, the part of the orbit of a satellite in which the satellite approaches nearest to its primary. Thus at perisaturnium the satellites of Saturn are nearest Saturn. [PERIGEE.]

Periplus (Gr. περίπλους, from περί, and πλέω, *I sail*). A circumnavigation. The word is used only as the title of some fragments which remain to us of narratives of voyages of the classical ancients. The *Periplus* of Hanno is a Greek translation (real or supposititious) of an inscription said to have been erected at Carthage in memory of a voyage along the western coast of Africa, respecting which much discussion has arisen among modern geographers. The date of this voyage is uncertain, but generally fixed by conjecture at 400 or 500 years before Christ. The *Periplus* of Scylax, which is supposed to belong to the age of Augustus, contains a succinct account of some journeys along the coasts of Europe and Asia. Two works bearing the same title pass under the name of Arrian, who wrote in the second century after Christ; the first contains a description of the Euxine, the second of the Erythræan Sea (Persian Gulf). (Sir G. Lewis, *Astronomy of the Ancients*, 454, 504.)

The work sometimes spoken of as the *Periplus* of Cosmas, is the *Topographia Christiana* of a merchant who in the time of Justinian received the name of Indicopleustes, from his voyages in the East. Some account of his geographical theories may be found in Gibbon, *Roman Empire*, ch. xlvii.; and Lecky, *Rise and Progress of Rationalism in Europe*, vol. i. 293 &c.

Peripneumony (Gr. περιπνευμονία). Inflammation of the lungs. [PNEUMONIA.]

Peripteral (Gr. περίπτερος). In Architecture, a building surrounded with a wing, aisle, or passage. The word *peripteral* denoted those Greek temples in which the cella is surrounded by a single row of columns, to distinguish them from the dipteral, in which two rows of columns surrounded the cella.

Peris. In the Persian Mythology, a class of imaginary beings closely allied to the elves or fairies of more northern latitudes, supposed to be the descendants of the fallen angels, and excluded from Paradise till they have made atonement for their sins. This notion is illustrated in Moore's poem of 'Paradise and the Peri,' in *Lalla Rookh.* [FAIRIES.]

Periscii (Gr. περίσκιος, from περί, and σκιά, *shadow*). A name applied by geographers to the inhabitants within the arctic and antarctic circles, because, as the sun at certain times of the year does not set to them in the course of his diurnal revolution, their shadows describe an entire circumference.

Perisperm (Gr. περί, and σπέρμα, *seed*). In Botany, a term used by some to denote the testa or skin of a seed, and by others the albumen of a seed.

Perissodactyla (Gr. περισσός, *odd*, and δάκτυλος, *finger*). An order of hoofed Gyrencephalate mammalia with functional toes on the hind foot, of uneven number, as *one* or *three*, and which have a simple stomach and an enormous or complex cæcum. The order has existed from the Eocene period to the present day. It comprises the following genera, the fossil forms being marked in italics, and those with the typical diphyodont dentition with an asterisk. Rhinoceros, *Acerotherium*, Hyrax, *Elasmotherium*, *Hysterotherium*, Tapirus, *Harlanus*, *Platygonus*, **Coryphodon*, *Lophiodon*, **Pachynolophus*, **Pliolophus*, **Hyracotherium*, *Stereognathus*, (?) **Anchilopus*, **Lophiotherium*, *Tapirulus*, *Listriodon*, **Palæotherium*, *Propalæotherium*, *Paloplotherium*, **Anchitherium*, **Hipparion*, Equus, *Macrauchenia*.

Peristaltic (Gr. περισταλτικός, *compressing*). A term applied to the peculiar motion of the intestines, by which their contents are gradually propelled from one end of the canal to the other.

Peristerite (Gr. περιστερά, *a pigeon*). A variety of Albite from Bathurst in Canada; so called from the resemblance of its iridescent play of colours to the hues of a pigeon's neck.

Peristome (Gr. περί, and στόμα, *a mouth*). The fringe of teeth seen round the edge of the cup in the capsule of a Moss, when the lid is broken off. The teeth of which it is composed are various in number and character.

Peristomes (Gr. περί, and στόμα, *a mouth*). The name of a family of Pectinibranchiate Gastropods, including those species in which the shells have the margin of the aperture or mouth unbroken and continuous.

Peristylium (Gr. περιστύλιον, from περί, and στῦλος, *a column*). In Architecture, a court, square, or cloister, with columns on three sides. In peristylia with columns on each of the four sides, the range towards the south is frequently higher than the rest. This species was called a Rhodian peristylium.

Peritonæum (Gr. περιτόναιον, from περιτείνω, *I stretch round*). The membrane which

envelopes the abdominal viscera, and lines the cavity of the abdomen. Hence also *peritonitis*, or inflammation of the peritoneal membrane.

Peritrochium (Gr. περιτρόχιον, from περί, and τρέχω, *I run*). In Mechanics, a wheel or circular frame of wood, fixed upon a cylinder or axle, round which a rope is wound. The wheel and cylinder being movable about a common axis, a power applied to the wheel will raise a weight attached to the rope with so much the greater advantage as the circumference of the wheel is greater than that of the cylinder. This mechanical power is called the *axis in peritrochio*; the windlass and capstan are constructed on the same principle.

Periwinkle (Fr. pervenche). The common name for *Vinca*, a genus of Apocynaceous plants, comprising but few species. *V. major*, *minor*, and *herbacea*, are amongst the more interesting of hardy perennials adapted for rockwork.

PERIWINKLE. In Zoology, the *Littorina littorea* of Lamarck, a shell which is found on the shores of all the northern coasts of Europe. Much variation exists amongst the individuals of the species, as to the relative developement of the spire, and of the lip, and in the thickness of the shell.

Perjury (Lat. perjurium). In Law, the taking of a wilful false oath or affirmation, by a witness lawfully required to depose the truth in a matter of some consequence to the point in question. A false oath, therefore, taken before no court, or before a court incompetent to try the issue in question, does not constitute the offence of perjury at common law. But many statutes provide that a false oath or declaration made on some specified occasions or for some particular purposes shall be considered to be perjury, and punishable accordingly. Perjury is a misdemeanour at common law, and by several statutes punishable by fine and imprisonment, and by penal servitude for a term not exceeding seven years.

Perkunos. One of the chief divinities of ancient Prussia, who, together with Rikollos and Potrimpos, formed the Trinity of the Slavonic nations. He was regarded as the god of the elements; and his worship extended to Russia, Poland, and Bohemia. (Grimm's *Deutsche Mythologie*.)

Perlite. A mineralogical synonym for Pearl-stone.

Permanent Axes. At any point of a body, permanent axes are the axes around each of which, if the body be caused to rotate, the centrifugal forces thus generated will either be in equilibrium or have a simple resultant passing through that point. They coincide with the principal axes at the point. When the latter point itself coincides with the centre of gravity, the centrifugal forces will also balance each other as to effects of translation, and thus the rotation-axis will remain unchanged during the whole motion.

Permanent White. Sulphate of baryta, when used as a pigment. It is not, like white lead, liable to discolouration.

Permanganic Acid, called also **Hypermanganic Acid.** A compound of two atoms of manganese with seven atoms of oxygen. It has been obtained in carmine-red acicular crystals. Its salts are of a fine red or purple hue.

Permian. This name was given by Sir Roderick Murchison, and has been accepted by most geologists in various parts of the world, as a convenient designation for rocks forming the uppermost of the great palæozoic series, and appearing, in England, to pass by almost insensible gradations into the beds of the new red sandstone belonging to the mesozoic or secondary period.

Russia, in that part of Eastern Europe which contained the ancient kingdom of Perm, afforded to Sir Robert Murchison large and well-marked fossiliferous rocks, having definite mineral characters, which enabled him to draw a line of demarcation not so clear elsewhere, but sufficient to serve as a useful guide when once identified.

The Permian series includes in England (1) the magnesian limestone, which directly underlies the new red sandstone, to which it is generally though not always unconformable, and (2) a series of sandstones, called the lower new red sandstone, passing into the coal measures; and often containing fossil vegetation almost identical with that of the coal period.

In Germany there is a series of beds of the same age, but in which the magnesian limestone is represented by some peculiar magnesian deposits much more shaly than in England, and these overlie a remarkable bituminous shale, containing numerous fossil remains of fishes, and much copper ore, worked at Mansfeld in Thuringia. Below this is a sandstone not unlike that of England.

The Russian representatives of these beds occupy a tract measuring seven hundred miles in one direction by four hundred in another, in a trough of carboniferous limestone. They are fossiliferous, including rocks and fossils identical with those of our own magnesian limestone and the German bituminous schist. They also contain curious remains of reptiles like some that have been found near Bristol.

Besides reptiles and fishes, the rocks of this period contain numerous shells and corals, which are characteristic and peculiar. [MAGNESIAN LIMESTONE; KUPFER SCHIEFER.]

Permit (Lat. permitto, *I allow*). An order or written permission from an officer of the customs, authorising the removal of goods, subject to excise duties, from one place to another.

Permutants (Lat. permutantes, part. of permuto, *I change*). In Algebra, functions which include commutants and determinants, as well as other functions of a like kind. To give a simple example:

$$V_{1,2,3} - V_{1,3,2} + V_{2,3,1} - V_{2,1,3} + V_{3,1,2} - V_{2,2,1}$$

denotes a permutant in which the symbol V with its suffixes may represent any quantity whatever dependent upon the arrangement of

these suffixes, and the signs of the successive terms follow the ordinary *rule of signs*. [RULE OF SIGNS.] If $V_{i,j,k}$ denote the product $a_i\,a_j\,a_k$, the permutant becomes a determinant. Papers on Permutants and Commutants by Professors Sylvester and Cayley will be found in the *Cam. and Dub. Math. Journal*, vols. vi. and vii.

Permutations (Lat. permutatio, from muto, *I change*). In Algebra, the different arrangements that can be made of a number of objects by changing their order. Thus *a b c, b c a, c a b, a c b, b a c, c b a*, are the six possible permutations of three letters. The number of different permutations that can be made of n different letters is equal to the product of the first n numerals 1, 2, 3, . . n. This number, which is always even, is often expressed by the symbol $n|$. When the objects, or letters, are not all different, the number of distinct permutations is, of course, diminished. If there are p_1 of one kind, p_2 of another, p_3 of a third, and so on, the number of permutations can be easily shown to be $\dfrac{n|}{p_1|\,p_2|\,p_3|\,\cdots}$

Thus from the word *ecclesiastical*, which contains 14 letters, two of which are *a*, two *e*, two *l*, two *i*, two *s*, and three *c*,

$$\frac{14|}{2|\,2|\,2|\,2|\,2|\,3|}=454053600 \text{ different words,}$$

pronounceable and unpronounceable, could be formed. For another application of this formula, see MULTINOMIAL THEOREM.

In many algebraical enquiries, as for instance in the theory of determinants, it is of importance to examine more closely the mode in which any permutation of a group of symbols may be obtained from the primitive arrangement. Cramer, in the appendix to his *Analyse des Lignes Courbes*, divides the permutations of a given set of symbols into two equally numerous classes; those of the one class contain an odd and those of the other an even number of *displacements*; it being understood that any two symbols in a permutation give rise to a displacement if their order of sequence is the opposite of that of the same two symbols in the primitive arrangement. Thus, taking the first six numerals in their natural order as a primitive arrangement, the permutation 251463 would contain six displacements, viz. (2, 1), (5, 1), (5, 4), (5, 3), (4, 3) and (6, 3), but 241563 only five; so that the two permutations would belong to opposite classes. *Every interchange of two symbols changes the class of the permutation.* Thus A g B h C and A h B g C are necessarily permutations of opposite classes, if g and h denote any two symbols whatever in their natural order, and A, B, C, any groups of symbols. For, neglecting the displacements arising from the symbols in A and C as being common to both permutations, the first will contain $(\beta-\beta_1)+\beta_2$ additional displacements if, of the β symbols in B, β_1 are greater than g, and β_2 greater than h; and the second will contain $1+(\beta-\beta_2)+\beta_1$. Now the difference between these numbers of displacements is $2\,(\beta_1-\beta_2)+1$, which is necessarily an odd number. From this it follows that in whatever way one permutation may be obtained from another by repeated interchanges of two symbols, the number of such interchanges must be constantly even or constantly odd.

A *cyclical permutation* of any group of symbols is obtained by replacing each symbol by the next following one, and the last by the first; thus *b c d a* is a cyclical permutation of *a b c d*. The formation of a cyclical permutation of n symbols requires at least $n-1$ interchanges of two symbols, and may always be effected with this number. Any permutation whatever may be regarded as composed of one or more cyclical permutations of groups of symbols taken from the primitive or any other arrangement. Thus in obtaining 416253 from the primitive arrangement, 1 has been changed to 4, 4 to 2, and 2 to the starting symbol 1; again, 3 has been changed to 6, and 6 to 3; and lastly, 5 has been left unchanged. Counting the last as one, therefore, 416253 may be said to consist of three cyclical permutations of three, two, and one symbols respectively. The minimum number of interchanges required, therefore, in the formation of this permutation from the primitive is equal to $(3-1)+(2-1)+(1-1)$ or $(3+2+1)-3$ or $6-3$, i.e. *to the difference between the total number of symbols and the number of cyclical permutations.* This law is general, and was first discovered by Cauchy. (*Jour. de l'École Polytechnique*. cah. 17.)

Pernambuco Wood. The wood of *Cæsalpinia echinata*.

Pernancy (Nor. Fr. perner). In Law, the taking or receiving of rents, profits, &c.

Pernio. [CHILBLAIN.]

Peroneal Muscles (Gr. περόνη, *the fibula*). Muscles arising from the fibula, and concerned in the movements of the foot.

Peronospora (Gr. περόνη, *a pin*, and σπορά, *seed*). The genus of microscopic fungi to which belongs the minute mould or fungus which is generally believed to cause the potato disease. The *Peronosporæ*, observes Mr. Berkeley, are most active agents in the destruction of vegetables, and it is to the ravages of *P. infestans* that the potato murrain is due. The same plant has been called *Botrytis infestans*. In these fungi, the mycelium creeps amongst the loose tissues of living leaves, and rapidly causes their destruction

Peroration (Lat. peroratio). The concluding part of an oration, in which either the arguments of the speech are recapitulated, or an appeal made to the sentiments or passions of the audience.

Perowskine. A mineralogical synonym for Tetraphyline.

Perowskite or **Peroffskite.** A titanate of lime, found in cubes of an iron-black colour in chlorite slate at Achmatowsk in the Ural, and at Schelingen in the Kaiserstuhl. Named after count von Perowski.

Peroxide. The highest degree of oxidisement of which a metal or other substance is susceptible without becoming an acid.

Perpendicular (Lat. perpendiculum, *a plumb-line*). In Fortification, a line drawn perpendicularly from the point of bisection of the exterior side, towards the place.

PERPENDICULAR. In Geometry, a straight line is said to be perpendicular to another straight line when the adjacent angles formed by their intersection are equal, and, consequently, each is a right angle. A straight line is perpendicular to a curve at a given point when it is perpendicular to the tangent to the curve at that point. In this case the perpendicular is usually called a *normal* to the curve. [NORMAL.] A straight line is perpendicular to a plane when it is at right angles with every straight line in the plane passing through the point of intersection. A plane is perpendicular to a plane when any straight line in the first, which is perpendicular to the common intersection of the two planes, is also perpendicular to the second plane.

Perpendt Stone. In Architecture, a stone that goes through the walls, and is dressed on both sides as a common piece of ashlar. The French term *purpaignc* is used to express the heading course of the bond; but in England, it seems to have been restricted to stones appearing in the two faces of the walls, with a dressed face on either side under the name of perpendt stone.

Perpetual Motion. In Mechanics, a machine which, when set in motion, would continue to move for ever, or at least until destroyed by the friction of its parts, without the aid of any exterior cause. The discovery of the perpetual motion has always been a celebrated problem in mechanics, on which many ingenious, though in general ill-instructed, persons have consumed their time; but all the labour bestowed on it has proved abortive. In fact, the impossibility of its existence has been so fully demonstrated from the known laws of matter and of the conservation of force, that it is rather an insult than a praise to say of anyone that he has occupied himself with the research. Nevertheless, the pursuit of the chimera has been the cause of many useful inventions.

In speaking of the perpetual motion, it is to be understood that from among the forces by which motion may be produced we are to exclude not only air and water, but other natural agents, as heat, atmospheric changes, &c. The only admissible agents are the inertia of matter and its attractive forces, which may all be considered of the same kind as gravitation.

It is an admitted principle in philosophy that action and reaction are equal; and that when motion is communicated from one body to another, the first loses just as much as is gained by the second. But every moving body is continually retarded by two passive forces, the resistance of the air and friction. In order, therefore, that motion may be continued without diminution, one of two things is necessary—either that it be maintained by an exterior force (in which case it would cease to be what we understand by a perpetual motion), or that the resistance of the air and friction be annihilated, which is physically impossible. The motion cannot be perpetuated till these retarding forces are compensated, and they can only be compensated by an exterior force; for the force communicated to any body cannot be greater than the generating force, and this is only sufficient to continue the same quantity of motion when there is no resistance. To find the perpetual motion is therefore a proposition equivalent to this: to find a force (either an attractive force, like that of gravitation or magnetism; or an elastic force, that of a spring for example) greater than itself.

But it may be argued that by some arrangement or combination of mechanical contrivances a force may be gained equal to that which is lost in overcoming friction and atmospheric resistance. This notion at first mention appears plausible, and is in fact that by which most speculators have been led astray. It is, however, entirely erroneous; for by no multiplication of forces or powers by mechanical agents can the quantity of motion be increased. Whatever is gained in power in lost in time; the quantity of motion transmitted by the machine remains unaltered.

Although the perpetual motion has been demonstrated again and again to be impossible on any known principle of mechanics, projectors have not thereby been deterred from the pursuit. In 1775 the Academy of Sciences at Paris resolved not to consider or admit into their *Memoirs* any future proposal for the discovery of the perpetual motion; yet such appears to be the seductive nature of the subject, that innumerable schemes, designs, and projects for accomplishing it have since been put forward; and there are instances of men of no common attainments and reputation, and well versed moreover in the principles of mechanical science, who have been deceived by the ingenious frauds of charlatans and impostors into a belief of its actual discovery. (Montucla, *Hist. des Math.* tome iii. p. 813; *Repertory of Arts*, vols. vii. and xiv.; *London Journal of Arts*, May 1827; Airy, *Trans. of the Cambridge Phil. Soc.* vol. iii. part ii.; Poppe, *Wunder der Mechanik*, 1832; and various papers in the earlier volumes of the *Mémoires de l'Académie des Sciences*, and the *Philosophical Transactions*.)

Perpetuity (Lat. perpetuitas). In the Doctrine of Annuities, the sum of money which will purchase a certain annuity to continue for ever. Thus, money being worth 4 per cent. the value of a perpetual annuity of 100*l.* will be 2,500*l.*

PERPETUITY. In Law, the continuance of property in a given course of devolution for ever or for a period beyond reasonable limits. The policy of English law has always been strongly opposed to this, and the present rules on the subject have been gradually formed by a

long course of judicial decisions. The subject is highly technical, and admits of distinctions too subtle for full explanation in a short compass; but the general rule may be stated to be, that a future or executory interest in property must be so given as to vest absolutely in some person within the period of a life or lives in being and twenty-one years afterwards; and any gift which *by possibility* might not vest within this period will be wholly void even though in event it may in fact fall within the limit. Thus, if a legacy is given to one for life with remainder to such of his children as attain the age of twenty-two years, the gift to the children will be void even if they all attain the age of twenty-two years in the lifetime of their parent; and many gifts are invalidated on similar grounds. The rule does not apply to limitations of real property preceded by an estate tail; for, as the tenant in tail has the power of acquiring the absolute fee simple and discharging the subsequent limitations, the remoteness of the event on which they may have been intended to arise will not affect their validity; and gifts for charitable purposes (which, however, are subject to peculiar restrictions of their own) are also excepted from the rule. With respect to contingent remainders in an entail, there is usually said to be a further restriction, embodied in the maxim that no remainder can be given to an unborn child followed by a remainder to any of the issue of such unborn child; but whether this restriction is merely an example of the rule against perpetuities, or an independent rule, is a point as yet hardly settled. (Williams *On Real Property*, p. 254.) Attempts to accumulate the income of property for the benefit of a future owner have been further restrained by the Thellusson Act (39 & 40 Geo III. c. 98), which forbids the accumulation of income for any longer period than the life of the settlor, or twenty-one years from his death, or the minority of some person who if of full age would be entitled to the income in question. The Act does not apply to provision for paying debts or raising portions. Perpetual settlements of estates have been in some cases, such as those of Blenheim and Strathfieldsaye, established by Act of Parliament, usually as a reward for great public services.

Perpeyn Wall. A pier, buttress, or other support, projecting from a vertical wall to receive the thrust of a beam, or of a roof, &c.; this would be built in perpendt ashlar.

Perpignan Wood. A French name for the wood of *Celtis australis*.

Perry (Lat. pirum, *a pear*). A fermented liquor made from pears, in the same manner as cider from apples. The pears best fitted for producing perry are exceedingly harsh and tart; but the liquor is pleasant and wholesome.

Persea (Gr. περσέα). A genus of *Lauraceæ*, containing the Avocada or Alligator Pear. This tree, *P. gratissima*, which is common in the West Indies and tropical America, grows to a moderate size, and bears large pear-shaped fruits, which are highly esteemed in the countries where they are produced, though not at first relished by strangers. They contain a large quantity of buttery or marrow-like pulp, which is eaten with spice, lime-juice, or pepper and salt. They also yield oil. The seeds are used for marking linen, as they leave an indelible black stain.

Persecutions (Lat. persecutio, from sequor, *I follow*). The name by which several periods in the history of the Christian church are distinguished. The persecutions which occurred in the first centuries of the Christian era, originated in the desire of the Gentile nations to suppress the Christian faith. On the accession of Constantine to the throne of the Western world, these persecutions ceased; and the subsequent history of the church is disfigured by persecutions raised by the more powerful against the weaker of the Christian sects.

In his *History of Rationalism in Europe* (i. 360, ii. 97, &c.), Mr. Lecky asserts that persecution is the logical and necessary result of the doctrine of exclusive salvation, and that the man who 'with realising earnestness' believes this doctrine 'will habitually place the dogmatic above the moral element of religion; he will justify, or at least very slightly condemn, pious frauds or other immoral acts that support his doctrines, . . . and he will, above all, manifest a constant tendency to persecution.'

Persephonê. In Greek Mythology, a daughter of Zeus and Dêmêtêr: but the name occurs in many forms, as Persephassa, Persephatta, &c., the first part of the word reappearing in Perseus. The story of her abduction by Hades or Polydegmon, while she was playing in the fields of Enna, of the woeful wanderings of Dêmêtêr in search of her daughter, and of her sojourn in the house of Keleos at Eleusis, is told in the beautiful Homeric hymn to Dêmêtêr, which relates how Hades was compelled to part with Persephonê for six months of each year, and how she is compelled to return to him by having eaten the pomegranate seed.

This legend, which is not noticed in the *Iliad* or *Odyssey*, was localised in many other places besides the Sicilian Enna; but the story resolves itself spontaneously into mythical phrases which told of the change of seasons. The abduction of Persephonê grew out of expressions which spoke of the departure of summer. Her abode in Hades is the hiding of the earth's treasures in cheerless Nifelheim, the land of the Niflungs or children of the mist [Nephelê], during the slumber of the beautiful maiden (for Persephonê is especially called Korê, *the girl*) round whom is coiled the serpent Fafnir. Her return is the reawakening of this fair maiden, who can be roused by the touch of one brave knight alone, the invincible Sigurdr, or Chrysaor, or Perseus.

The mystical theories of the Orphics did some violence to this simple tale. Representing Persephonê as the all-pervading goddess who produces and destroys everything, they identified her with Isis, Rhea, Gê, Hecatê, Pandora, and other mythical beings, and made

her the mother of DIONYSOS, ZAGREOS, and Iacchus. [BACCHUS.]

Perseus (Gr. *the destroyer*). In Greek Mythology, the son of the golden shower and of Danaê, daughter of Acrisios, king of Argos. The main substance of the myths of Perseus, although the incidents vary in different versions, is as follows.

Before his birth, the Delphian oracle had announced that if Danaê had a son, he would be the slayer of his grandfather Acrisios, who accordingly shut up Danaê in a strong tower. But Zeus entered in the form of a golden shower, and Danaê, becoming the mother of Perseus, was with the infant thrown into the sea in a chest, which the winds carried to the island of Seriphos. There they were found by Dictys, and brought before the king Polydectes, who, failing to win the love of Danaê, treated her with great cruelty, and to punish her sent Perseus to bring the head of the mortal gorgon. [MEDUSA.] To enable him to do this, Athena gave Perseus a mirror by means of which he might slay the gorgon without looking on her face, which, if seen, would turn him into stone. Hermes also gave him the sword of Apollo Chrysaor [PEGASUS], while from the ocean nymphs, to whom he had compelled the Graiæ to guide him, he received the winged sandals, and the helmet of Hades, which rendered the wearer invisible. Thus armed, he entered the gorgon land in the far west, slew Medusa, and putting her head in a bag, likewise given to him by the nymphs, escaped from her sisters, who pursued him as he hastened to the gardens of the HYPERBOREANS. From this peaceful region he wandered on into Æthiopia (the *brilliant* land), and there rescued Andromeda from the sea-monster, and married her in spite of Phineus, before whom he unveiled the fatal head of the gorgon. But there was more work yet to be done by the head of Medusa, which had turned ATLAS into a mountain. With Andromeda Perseus returned to Seriphos, and there at a banquet displayed the gorgon's face before Polydectes, who with his supporters turned into stone. Perseus then made Dictys king, and giving the sandals and helmet to Hermes, surrendered the gorgon's head to Athena, who placed it on her shield. As Perseus approached Argos from Seriphos, Acrisios, remembering the Pythian warning, fled to Larissa, whither Perseus followed him, to persuade him to return. There in some games Perseus accidentally killed Acrisios, and, in grief for what he had done, gave up Argos to his kinsman Megapenthes, and received from him the throne of Tiryns, where he died.

This dynastic legend of the Perseidæ the men of Argos regarded as a history essentially distinct from the dynastic legends of Athens and Thebes. In reality, all three are different versions of the same tale. Like THESEUS, the hero of Attica, and ŒDIPUS, the hero of Thebes, Perseus is a destroyer, both purposely and against his will. His slaughter of Medusa and the sea-monster answers to the destruction of the MINOTAUR by Theseus and of the SPHINX by Œdipus; and as he unwittingly slays Acrisios, so Theseus unknowingly causes the death of Ægeus, and Œdipus kills Laïos, not knowing him to be his father. The name Perseus, again, has the same force with that of Apollo, the slayer of the serpent Python; and if his labours are forced on him by the cowardly Polydectes (a name which recalls that of Polydegmon, a synonym for Hades), so also was Heracles forced to do the bidding of the mean Eurystheus, and Apollo was compelled to serve as a bondsman in the house of Admetus. If Perseus is the son of Danaê and the golden shower, so is Theseus the child of Æthra, the pure air, and Phœbus springs to life and light (Lykêgenês, *the light-born*) in Delos, or in ORTYGIA, the morning land. The restoration of Danaê to Argos, after his great toil is done, is the restoration of Iolê to Heracles, of Antigonê to Œdipus, of Penelopê to Odysseus. Perseus, Heracles, Bellerophon, Kephalos, Odysseus, all journey from the east to the west; all have invincible weapons, which none but themselves can wield. The golden sandals of Perseus answer to the golden chariot of Helios, and the golden armour which bears Achilles like a bird upon the wing. (*Iliad* xix. 386.) While the faint and neutral character of Danaê is repeated in LÊTO the mother of Phœbus, in Alcmênê the mother of Heracles, in Hecabê the mother of PARIS, and in Iocastê (Jocasta) the mother and wife of Œdipus, the exposure of Perseus on the sea is only one form of the ordeal through which all the solar heroes have to pass in their infancy.

PERSEUS. One of the forty-eight constellations, situated in the northern hemisphere.

Perseverance (Lat. perseverantia). In Theology, the continuance of the elect in a state of grace to the end of their lives, which, according to some theologians, must always be the case with him who has once been truly called into such a state. Since God is represented as the image of perfection and immutability in Himself, so, it is argued, having once begun the preparation of a human being for a blessed eternity, He will not leave His work unfinished; but the person concerned must necessarily persevere to the end in a state of acceptance, under the absolute decree of which he was originally elected unto life.

Persian Berries. The berries of the *Rhamnus infectorius*, called in France *graines d'Avignon*. They are used by calico-printers and dyers, as a source of a yellow colouring matter, which has been called Rhamnine.

Persian Wheel. In Mechanics, a contrivance for raising water to some height above the level of a stream. In the rim of a wheel turned by the stream a number of strong pins are fixed, from which buckets are suspended. As the wheel turns, the buckets on one side go down into the stream, where they are filled, and return up full on the other side till they reach the top. Here an obstacle is placed in such a position that the buckets successively

strike against it and are overset, and the water emptied into a trough. As the water can never be raised by this means higher than the diameter of the wheel, it is obvious that this rude machine is capable of only a very limited application. Sometimes the wheel is made to raise the water only to the height of the axis. In this case, instead of buckets, the spokes are made hollow, and bent into such a form that when they dip into the water it runs into them, and is thus conveyed to a box on the axle, whence it is emptied into a cistern. Such wheels are in common use on the banks of the Nile and elsewhere.

Persistence (Lat. persisto, *I continue*). In Optics, this term signifies the duration of the impression of light on the retina after the luminous object has disappeared. The persistence on the human retina is about one-tenth of a second. Thus, if a lighted torch is whirled round rapidly, a continuous circle of light is seen. A great number of illusions of the same kind, as the augmentation of the apparent volume of a musical chord when in vibration, the luminous train accompanying a falling meteor, &c., are explained by this property of vision; and it has been ingeniously applied by Professor Wheatstone to measure the velocity of electric light.

Person. [GRAMMAR.]

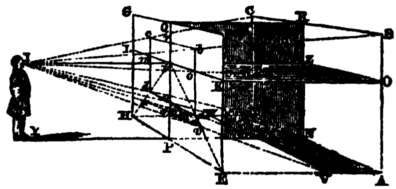
Personal Identity. [IDENTITY, PERSONAL.]

Personal Property. According to the division recognised by our law, personal property was originally considered to consist of goods and chattels (derived from the barbarous Latin word *catallum*), as distinguished from the 'lands, tenements, and hereditaments' of which real property was composed. [REAL PROPERTY.] The primary division was undoubtedly into things movable and immovable. In process of time, however, certain estates or interests in land grew up which were unknown to the feudal system, and could not conveniently be subjected to its rules. Such were leases for years, which, being considered as chattels, yet of a *real* nature, were denominated *chattels real.* Besides chattels real, personal property is said to be either *in possession* or *in action.* The first class of objects includes everything comprehended under goods and chattels, ready money and stock, or such animals as are the subjects of property: the second class are legally termed *choses* or things *in action*, and are defined to be things to which a man has a bare right without any occupation, the possession whereof may be recovered by a suit or action at law. Of this class, therefore, are all debts, and the securities for them, unless these securities attach on land, in which case, however, although real property in law, they are in equity considered as mere accessories to the debts secured. Sums of money due on bond, on bills of exchange, and promissory notes, property in the funds or in public companies, all fall within this comprehensive class, which, originally so trifling as to be hardly noticed in early jurisprudence, now comprehends by far the greater part in value of the movable property of our commercial community. The subjects of personal property are distinguished from real property by being unaffected by the feudal rules of tenure, by being alienable by methods altogether different, by passing in the first instance to the executors when bequeathed by will, and by devolving, on their owner's intestacy, not on his heir, but on an administrator appointed by the Court of Probate, by whom they are distributed amongst the next of kin of the deceased. (Williams, *On Personal Property.*)

Personate (Lat. persona, *a mask*). In Botany, a term applied to that form of monopetalous corolla, in which the limb is unequally divided in a two-lipped manner, the upper lip being arched, and the lower prominent and pressed against it, as in the Snapdragon.

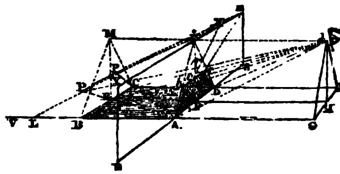
Personification or **Prosopopœia** (Gr. προσωποποιΐα). In Rhetoric and Composition, a figure of speech, being a species of METAPHOR by which inanimate objects, or abstract notions, are represented as endued with life and action: sometimes by being addressed as living agents [APOSTROPHE]; at other times, by being coupled with attributes which belong only to living agents.

Perspective (Lat. perspicio, *I look through*). In the Fine Arts, the art of delineating on a given transparent plane or superficies objects as they appear to an eye placed at a given height and distance. From this definition it is evident that to delineate the true appearance of an object on a plane surface, it is necessary to know the laws according to which the apparent linear dimensions of an object increase or decrease; and they are these generally: 1. The visual angle, or the apparent magnitude of a line, will be less the greater the distance, and the converse; 2. It will be less the more obliquely a line is viewed; 3. The law of diminution will be nearly in proportion to the obliquity and distance conjointly. In the following diagram, let the eye of the



spectator be at I, and let E F G H be the plane on which the appearance of objects is observed. This is called the *perspective plane*, or *plane of the picture.* Now the appearance of every object to be delineated will vary according to the plane in which it stands, considered with respect to the perspective plane; hence the particular situations of object planes are the main points for consideration. It is manifest that any plane passing through the eye can

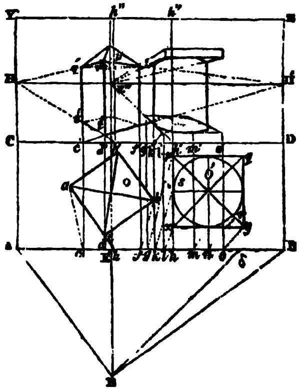
only be seen on the perspective plane as a line; for the eye, having neither elevation above nor depression below such plane, can see no part of its surface, its edge being all that is visible to the eye. Of such planes two are of primary importance in perspective; viz. the *horizontal plane*, O K L M, parallel to the horizon; and the *vertical plane*, Q P R N, perpendicular to the last. The first intersects the perspective plane in the line L K, called the *horizontal line*; and the last in the line Q P, called the *vertical line*. Planes not passing through the eye must have a *direct* or an *oblique* situation relative thereto. If the former, it must be parallel to the perspective plane, which is supposed to be placed *directly* before the eye; thus, the plane A B C D is a direct one, and parallel to the perspective plane G E. Of the planes situated obliquely to the eye, the most considerable is A E H D, which is called the *ground plane*, and is parallel to that of the horizon. From the foregoing observations, then, it appears that objects in the surfaces of the horizontal and vertical planes cannot be seen by the eye at I; and therefore cannot be represented on the perspective plane. If O B be an object in the direct plane, and from the extreme points O and B the visual rays O I, B I be drawn to the eye at I, they will pass through the perspective plane in the points *o* and *b*, and by joining them the right line *o b* will be the representation of the line or object O B on the perspective plane. In like manner the representation of O A is *o a*, and *b r* and *a n* will be the representation of B R and A N, and consequently *r b a n* of R B A N, &c. &c. So all lines parallel to A B or C D in the object plane will have their perspective lines parallel to *a b* and *c d* in the picture on the perspective plane; and however the object plane A C may be divided, their representations on the perspective plane or planes of the picture will divide that in a similar manner. The distance of any point B in a direct plane from the horizontal or vertical plane has to the distance of its perspective from the horizontal or vertical line an invariable ratio, viz. that of the distances of the planes from the eye: hence the forms of objects on the perspective plane, when they are presented in a direct view, may be drawn with facility. The last species of plane whereon it is supposed we may view the natural object is that of the ground itself, as A D H E, above which the eye has more or less an elevation; as *i* P, equal to I Y. This is hence called the *ground plane*, and its intersection, H E, with the perspective plane is called the *ground line*. It is more important than all others, as being the common table, as it were, on which everything is placed. In respect to this horizontal plane, we have seen that the two remote angles thereof, A and D, are represented by *a* and *d* in the perspective plane; the other two angles, E and H, are in the same plane also, as being common to both; therefore, by drawing the lines *a* E and *d* H, there will be formed the figure *a d* E H on the perspective plane, which will be the correct perspective appearance of the ground plane A D H E. Thus, *a* E is the perspective of A E, *n* P of N P, and *d* H of D H; and lines that are parallel in the ground plane and perpendicular to the perspective plane are not so in their perspective picture, but converge to a point *i*, called the *point of sight*, in the perspective plane, because exactly opposite to the eye, or the point in which a perpendicular from the eye falls on the plane. In the ground plane draw V W parallel to A D; its perspective *v w* will be parallel to *a d* in the picture, and *a d w v* will be the perspective of the part A D W V in the original plane. We shall now proceed to a demonstration of what relates to forming the perspective appearance or picture of the ground plane and objects upon it. Let A B C D, in the following diagram, be a rectilineal figure on the ground



plane V G K C, contiguous to and at right angles with the perspective plane Y Z S R. F H is the distance of the plane, and H I the height of the eye at I. H E is parallel to G B or C K, and bisects A D and B C in the points F and E. On the point E raise the perpendicular E M, equal to H I, and draw the lines B M, C M, G I, and K I. Draw the visual lines, I A, I B, and I M, which is called the *principal ray*, and is perpendicular to the perspective plane in the point *i*. Now it is evident that the plane I G B M intersects the perspective plane in the line A *i*, and the ray B I, being in the said plane G M, must intersect the line A *i* in some point *b*, which is therefore the perspective of the point B: hence A *b* is the perspective of the line A B. Also, as the plane I K C M intersects the perspective plane R Z in the line D *i*, and the ray I C is in that plane, and intersects the line *i* D in the point *c*, that point will be the perspective of the point C, and D *c* that of the line D C. Joining the points *b c*, the line *b c* will be the perspective of the line B C in the ground plane. Let A B equal D C, then B C will be parallel to A D; and as in this case A *b* is equal to D *c*, *b c* will be parallel to A D also. From this it is manifest *that all right lines, as* B C *in the ground plane, which are parallel to the ground line* A D, *will also be parallel to the same in their representations on the perspective plane.* It is moreover evident *that the representations* A *b*, F *e*, D *c*, *of all lines* A B, F E, D C, *perpendicular to the ground line* A D, *converge or tend to the point of sight* *i* *in the perspective plane.* If the line A B be carried out infinitely in the direction of V, then, sup-

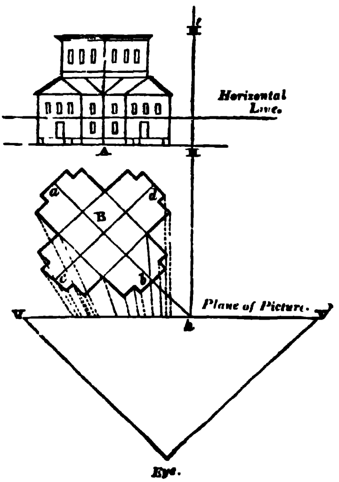
posing the point B to move along that line continually, the visual ray B I will keep rising on the plane I G B M towards I M, making the angle B I M less and less, till the point B being at an infinite distance, the ray I B will coincide with I M, and consequently the line A *i* will be the perspective of A B continued infinitely. So D *i* will be the representation of the line D C continued infinitely. Hence *the triangle* A *i* D *will, on the perspective plane, be the true representation of the plane* A B C D *carried out infinitely on the plane of the horizon.* Hence, also, the line Y *i* Z is the perspective of the horizon or boundary of the sight at an infinite distance; and therefore all objects on the plane of the horizon will, in their representations, be seen to rise from the ground line towards the point of sight and lessen in appearance as they grow more distant, till at last they vanish in the horizontal line Y Z. We now come to lines which lie oblique to, or make an angle with, the ground line A D, or any other parallel to it. Make A L equal to A G or I *i*, and draw A *p* to make any angle *p* A R or *p* A D with the base A D, acute or obtuse. Then in the horizontal line Y Z take *i* X, equal to L *p*, and draw *p* X and *i* X; the plane I X *p* A will intersect the perspective plane in the line A X. Draw the visual ray I *p*, which, being in the plane I X *p* A, must go through the perspective plane somewhere in the line A X, which suppose at *r*. Then is the point *r* the perspective of *p*; and since the point *p* is supposed to pass from A to *p*, in describing the line A *p* its perspective *r* will move in the plane A Z from A to *r*, and describe the line A *r*, which therefore will be the representation of the line A *p*. If A *p* be carried out infinitely, and the point *p* supposed to move constantly therein, its representation *r* will appear to move towards X, till at length the point *p* being at an infinite distance, *r* arrives at and coincides with X in the horizontal line. A X is therefore the representation of the line A *p* infinitely continued; and X is called the *accidental point*, to which the representations of all lines parallel to A *p* tend. Let L P be taken equal to A L, and *i* Z equal to *i* I; then, joining A P and *i* Z, the triangles A P L and *i* Z I are equal. Then will the plane *i* A P Z intersect the perspective plane in the line A Z, which will be the representation of the line A P carried to an infinite distance. But since A L is equal to L P, and L P is parallel to A D, therefore A P is the diagonal of a square, and contains an angle D A P of forty-five degrees with the ground line A D; hence the point of distance Z is that to which all rays parallel to A P tend in the perspective plane. Let A B equal A D; then is A B C D a geometrical square, and its diagonal A C, whereof the representation is A *c*; and the point *c* is therefore that in which the perspective diagonal A Z intersects the ray or radial line *i* D. Make *i* Y equal *i* Z, or *i* I, and join D Y, and it will be the perspective diagonal of D B (the other diagonal of the square A C), infinitely continued, and D *b* the representation of the diagonal B D, determined by the intersection of the lines D Y and A *i*, as before. Thus it is demonstrated that A *b c* D on the perspective plane A S Z Y is the true picture or perspective representation of the original square A B C D on the ground plane, as required.

From the above principles are deduced the common rules of perspective, of which we shall give two or three examples. A B C D is a ground plane, whereon are seated the objects O and O′. The line A B is the plan of the plane of the picture, or its intersection with the ground plane; and C D Y Z is the plane of the picture, or the perspective plane, as we have before called it. It will be observed that one of the objects, O, lies obliquely towards the perspective plane, and the other is parallel to it or direct. We will first deal with the former. From the station of the eye, E, parallel to *a e* and *e b*, two of the sides of the object, draw the lines E A and E B, cutting the plane of the picture in A and B. Then will A be the vanishing point of all lines parallel to *a e*, as will be B of all lines parallel to *e b*. E′ is the place of the eye at the intersection of the ground plane with the picture, being a perpendicular from A B to E′. If H H′ be the horizontal line, then H E″, equal to A E′, is the place of the eye on the perspective plane. From the different points of the object *a e b* draw towards E as a centre the visual rays *a c*, *e d*, *b f*, intersecting A B in *c*, *d*, and *f*; and from them continue upwards indefinitely the verticals *c c′*, *d d′*, *f f′*, which will be the boundaries of the sides *a e* and

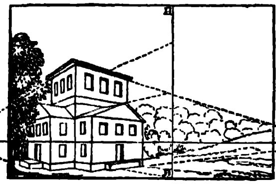


e b respectively. On the plan continue one of the sides *a e* till it intersects the picture in *k* and makes C *k′* on the perspective plane equal to A *k* on the plan; and draw the vertical *k′ k″* which will be the *line of heights* on which they are to be set out. Then, if *k′ p* be the height of the object O, lines drawn from *k′* and *p* to the vanishing point H will intersect the verticals in *q* and *r* and *s′* and *t′*. In like manner, lines drawn from *t′* and *r′* towards the

vanishing point H will give the representation of the other side. Lines drawn in opposite directions at the top of the figure (dotted in the diagram) will enable the draughtsman to draw diagonals from whose intersection a vertical may be raised for crowning the object with a pyramid or other figure. In respect to the object O′, which on the plan is a square circumscribing a circle, the object being direct or parallel to the picture, all those lines parallel to it will be horizontal, and the vanishing point of the returning sides *p x*, *q y* will be found in E′ (or E″ in the picture), which, as in the former case, is found by a line from E parallel to those sides intersecting the picture. Similarly, a line from E parallel to *x q*, intersecting the picture in δ, will be the vanishing point of all diagonals of a square in that direction. The visual rays tending to E, shown at *g k l*, &c., are to be transferred to the picture by verticals as before. In this object *h h′ h″* will be seen to be the line of heights, on which all heights are to be set out. The perspective extent of a circle is easily obtained by lines bounding its convexity, transferred by the visual rays *s k r n* to the picture, which, aided by the diameters, will give the form required. To give the reader a general notion of the common mode of proceeding in perspective representations of buildings, we present the following diagrams. B is the plan of a building to be thrown into perspective, inclined to the plane of the picture at any angle *v h a*. The vanishing points of all lines parallel to



a b are found by a line from the eye parallel to *a b*, cutting the picture in V. Similarly, V′ is found to be the vanishing point of all lines parallel to *c d*. If *a b* be continued to *h*, it gives the place of the line H H′, whereon the heights of the different parts of the elevation A may be set according to their several altitudes. The place of the horizontal line is chosen so as to afford the most agreeable representation of the object; its height depending, of course, on that at which the eye would most probably be placed, or might be supposed to be. The visual rays to the eyes are shown by the dotted lines. Having thus prepared the geometrical plan and elevation of the object, the plane of the picture is set out as under; and the reader must observe that the



whole extent of it horizontally must not take in an angle of more than sixty degrees, that being as great as the eye can take in without turning the head, though in internal views a greater extent is generally tolerated. It is to be observed that in this diagram the representation, for the sake of greater distinctness, is doubled in dimensions from the plan. The place of H H′ is transferred to the picture, and the height carried down from it to the vertical lines, whose places have been found by the visual rays above mentioned. The vanishing points V and V′ are transferred to the horizontal line V V′, and the horizontal lines in the sides tend thereto. It is obvious that a similar process enables the draughtsman to make internal representations, the principles on which they are conducted being precisely the same. It is needless to expatiate on the importance of perspective to the painter; and though Fresnoy has advised that 'the compasses should be rather in his eyes than in his hands,' it is clear that without a knowledge of its laws he can never hope to succeed.

That perspective was unknown to the ancients, as some have supposed, is a mistake. What has led to such an error has been, perhaps, the violation of its rules in basso-rilievo, and particularly in the reliefs of the Trajan Column, where attention to these rules would have been impossible, if not improper. Another ground for the supposition is the ignorance of perspective displayed in the paintings of Herculaneum and Pompeii. But such examples are no proof. How many painters of our own days, some of them even possessing a certain sort of reputation, are sadly ignorant upon the subject. The truth is, that the ancients were not only eminent for their success in painting walls with architectural subjects, but they were also known to have acquired the practice of this branch of the arts in the decorations of their theatres. To such a point of perfection was it carried, if we may rely on Pliny, that in the decorations of the theatre of Claudius Pulcher the imitations were so striking that the birds attempted to alight on the tiles of the roofs. This probably, however, is but a

figurative description of the work, and that it was so intended; for otherwise it would be drawing rather too largely on our credulity. Vitruvius tells us, in the preface to his 7th book, that perspective was well understood at a very early period. His words are, 'Agatharchus, at the time when Æschylus taught at Athens the rules of tragic poetry, was the first who contrived scenery, upon which subject he left a treatise. This led Democritus and Anaxagoras, who wrote thereon, to explain how the points of sight and distance ought to guide the lines, as in nature, to a centre; so that, by means of pictorial deception, the real appearances of buildings appear on the scene, which, painted on a flat vertical surface, seem nevertheless to advance and recede.' Neither was the practice of perspective confined to the representations just mentioned. Its knowledge was considered equally necessary in pictures. The painter Pamphilus, whose celebrated school of design was at Sicyon, taught perspective publicly, and carried his opinions on this head to such an extent that he considered no perfect painting could be executed without a knowledge of geometry.

The earliest authors on the subject whose works have reached us are Bartolomeo Bramantino of Milan, whose work, *Regole di Prospettiva e Misure delle Antichità di Lombardia*, appeared in 1440; and Pietro del Borgo, who, as he died in 1443, probably wrote earlier. Baltazzare Peruzzi, improving on the methods of Pietro, whom he had carefully studied, very considerably advanced the science. Guido Ubaldi followed him; and, publishing his work at Pesaro, in 1600, established its principles on a basis which left little to be done by our countryman Dr. Brook Taylor, the first Englishman who wrote scientifically on the subject. The works on the subject are in every language very abundant; but, in our own, the work of Thomas Malton, published in folio, London 1776, entitled *A complete Treatise on Perspective, in Theory and Practice, on the Principles of Dr. Brook Taylor*, is the most valuable to the student, and should be in the hands of everyone who has a desire to be thoroughly acquainted with the subject.

Perspective, Aërial. [Aërial.]

Perspiration (from Lat perspiro, *I breathe*). The vapour secreted by the ramification of the cuticular arteries over the surface of the body. In the healthy state it is slightly acid and saline. According to Lavoisier and Seguin, the greatest amount of perspiration exceeds six pounds in the twenty-four hours, and the smallest two pounds; it is at its maximum immediately after taking food, and decreases during digestion. Whatever quantity of food is taken, or whatever are the variations of the atmosphere, the same person, after having increased in weight by all the food he has taken, returns in twenty-four hours nearly to the same weight he was the day before, provided he is not growing and has not indulged in any excess.

The substances perspired are water, carbonic acid, saline substances, lactic acid, and some organic matter. In certain cases of disease, the perspiration is not only greatly modified as to quantity, but often as to quality. The perspiration is secreted by the *sudoriferous* or sweat glands, which are situated i small pits in the deep parts of the corium, or in the subcutaneous areolar tissue, surrounded by a quantity of adipose tissue. Their size varies; they are most numerous on the palm of the hand, and their total number is estimated by Krause to be 2,381,248 in the human frame.

Persymmetrical. [Matrix.]

Perthite. A reddish variety of Orthoclase, from Perth in Upper Canada.

Perturbation (Lat. perturbatio). In Astronomy, the deviation of a celestial body from the elliptic orbit which it would describe if acted upon by no other attractive force than that of the sun, or central body about which it revolves. If the planets exercised no attraction on each other, the orbit described by each of them would be accurately an ellipse, having the sun in one of its foci; and the law of the motion would be such that the area described by a straight line joining the centre of the sun and the planet would describe equal-areas in equal times. But in consequence of the universal gravitation of matter, every body in the system is more or less affected by the attractive influence of all the others, and is consequently forced to deviate from the path it would describe in virtue of the central force acting alone. The forces which cause these deviations are called the *perturbing* forces; and the determination of their effect on each orbit is the great problem of physical astronomy.

The simplest case of the problem is a system in which there are only three bodies—a central body and two revolving bodies, disturbing the motions of each other. Such, for example, would be the case of the sun, the earth, and the moon, if all the other planets were conceived to be annihilated, or at so great a distance that their disturbing force was rendered insensible. For the sake of perspicuity, let one of the revolving bodies be called the *disturbed* and the other the *disturbing* body. Now it is by no means difficult to obtain a general idea of the effects that must be produced by the disturbing force. It is easy to see, for example, that in certain positions of its orbit the motion of the disturbed body must be accelerated, and in others retarded; that in one case it may be drawn above, and in another depressed below the plane of the orbit which it would describe about the central body. But a far more difficult problem remains—namely, that of determining the ultimate effect of the reciprocal action of the revolving bodies after an infinite number of revolutions. When the masses and distances of the bodies are supposed to be given, this is a problem of pure mathematics; but such is its difficulty, that even when restricted to three bodies, its gene-

ral solution transcends the power of analysis; and it is only in a particular case (that, however, which is presented by nature), namely, when the mass of the disturbing body is very small in comparison of the central one, that mathematicians have succeeded in integrating the equations of motion, and determining the final results.

It is easy to conceive that if the problem presents great difficulties when only three bodies are taken into consideration, these difficulties must be infinitely increased when it is attempted to investigate the reciprocal actions of all the individuals composing the solar system. To determine the circumstances of the motions of so many bodies projected in space and abandoned to their mutual attractions, is a problem indeed which far transcends the power of any known calculus. Nevertheless, there are circumstances in the peculiar constitution of the solar system which enable us not only to foresee the effect, but to determine the form dimensions and position of an orbit, and the place of the body in it, at any given time, past or future, with all the precision which astronomical observations admit of. These circumstances are the following: In the first place, by reason of the immensely preponderating attraction of the sun, the force by which any planet is attracted by another is extremely feeble in comparison of that by which it is retained in the orbit it would describe if there was no other body than itself and the sun. Hence the deviations from that orbit are small, and the disturbing action of each planet admits of being computed independently of the others. In the second place, all the large planets are confined to a zone of a few degrees in breadth, and therefore can exert only a comparatively feeble influence in drawing one another from the planes of their orbits. In the third place, the system is broken up into subordinate and partial systems, which are almost independent of one another. Thus, for example, the sun, Jupiter, and Saturn form a system, in which the two planets exert a very sensible action on each other, but are very little affected by the influence of any other body; and the same is the case, though in a less degree, with Venus and the earth. By reason of these circumstances, mathematicians have been enabled to accomplish what would otherwise have been impossible, and to express th disturbing forces of the several bodies of the system by algebraic equations, from which the positions of all the planets and the principal satellites are computed for several years to come, and reduced into tables for the purposes of navigation.

The inequalities produced in the motions of the planets by their reciprocal actions are divided into two kinds. The first depend on the *configurations* of the planets, i.e. their relative positions with regard to each other; and, as the inequalities depending on this cause increase, diminish, and disappear after certain intervals of time, they are called *periodic inequalities*. Those of the second kind are independent of the relative positions of the planets: they are also periodic, but their periods are incomparably longer than those of the first kind; hence they are called *secular inequalities*, as if their periods were not to be reckoned by years, but by centuries. It is by the discovery of the periodic nature and ultimate compensation of all the inequalities of both kinds occasioned by the perturbing forces, that the permanent stability of the system is demonstrated.

In order to assure the stability of the planetary orbits, three elements must remain constant, or be subject only to small periodic fluctuations. These are: 1. The major axis of the orbit, or the planet's mean distance from the sun; 2. The inclination of its orbit to a fixed plane; and, 3. The eccentricity of the orbit. Now, with respect to the major axes, it has been demonstrated by Lagrange that they are exempted altogether from secular inequalities, and are subject only to periodical changes depending on the configurations of the planets. They are therefore restored to their former values when the planets resume the same relative positions; and their mean values, and consequently the mean motions which depend upon them, remain unalterably the same. With regard to the inclinations and eccentricities, they are affected both by periodic and secular inequalities; but their secular changes are confined within very small limits, and ultimately work out a compensation; and, further, the inclinations and eccentricities of the different orbits are connected with each other in such a manner, that whatever any one orbit gains in either of these respects is lost among the others. These relations are defined by the two following theorems, discovered by Lagrange, than which analysis has furnished no more remarkable or beautiful results:—

1. If the mass of every planet be multiplied by the square root of the major axis of its orbit, and the product by the square of the tangent of its inclination to a fixed plane, the sum of all these products will be constantly the same under the influence of their mutual attraction.

2. If the mass of each planet be multiplied by the square root of the axis of its orbit, and the product by the square of the eccentricity, the sum of all such products throughout the system is invariable.

From the periodic nature of the changes produced in the three elements mentioned above, it follows that the whole effect of the perturbing forces is to cause the system to oscillate about a mean state; that the inequalities of the planetary motions are all compensated in the long run; and that consequently the system contains within itself no element of destruction, but is calculated to endure for ever, unless an external force be introduced. These results of theory are, in a speculative point of view, by far the most

interesting in the whole range of astronomical discovery. They are not deduced, however, from the solution of the general problem of the motion of bodies mutually attracting each other, but are founded on certain conditions which belong to the individual system; viz. 1. That the eccentricities of the orbits are inconsiderable; 2. That the inclinations to the plane of the ecliptic are small; and, 3. That all the planets, primary and secondary, move in the same direction. Now these conditions are not necessary consequences of gravitation. For anything that has been proved to the contrary, a system might exist under the Newtonian law of gravitation in which not one of them would be satisfied. Of their final causes, however, we are, and may ever remain, entirely ignorant; but the fact of their existence (for the chances are almost as infinity to one that they are not accidental) proves clearly enough that the primitive impulse which determined the directions of the different motions must have been communicated to all the planets and satellites by the same mechanical cause.

The history of the problem of the perturbations dates from the discovery of universal gravitation. Newton himself pointed out the general effects which the mutual attractions of the planets must have in disturbing the motions of each other, and applied his theory to the investigation of the precession of the equinoxes, and the inequalities of the moon. The problem of three bodies was solved by Clairaut, D'Alembert, and Euler, about the middle of the last century. Euler first pointed out the periodic nature of the variations of the orbits of Jupiter and Saturn occasioned by their mutual perturbations. Laplace remarked that on taking account of some of the first terms of the analytical developement of the expressions of the perturbed orbits, those on which the secular inequalities depend are capable of increase only within certain limits; and Lagrange demonstrated generally that no secular inequality, or term proportional to the time, can possibly enter into the expression of the greater axis of the orbit, or the mean motion which depends on it. It may be said that the discoveries of these two great mathematicians completed the theory of gravitation, inasmuch as every inequality in the system not previously accounted for was by them referred to its proximate cause, and its analytical expression assigned. The labours of all succeeding mathematicians in the department of physical astronomy have been confined to the extension and simplification of their theories.

It may be affirmed that the discovery of the planet Neptune simply by means of a searching investigation into the unknown cause of some of the outstanding perturbations of the planet Uranus, for ever set the seal on the theory of universal gravitation.

M. Leverrier is now occupied upon a complete investigation into the mutual perturbations and masses of the different members of the solar system.

For a popular account of this subject, the reader may consult Laplace, *Système du Monde*, Sir J. Herschel's *Outlines of Astronomy*, and Airy's *Gravitation*. The mathematical theory is contained in the *Mécanique Céleste*, and other works on physical astronomy. (Playfair, *Outlines of Natural Philosophy*; Woodhouse, *Astronomy*, vol. ii.; Pontécoulant, *Théorie Analytique du Système du Monde*; Gautier, *Essai Historique sur le Problème des Trois Corps*.)

Pertussis. [HOOPING COUGH.]

Perule (Lat. perula, *a little satchel*). In Botany, the covering of a leaf-bud formed by scales.

Peruvian Balsam. The produce of the *Myrospermum peruiferum*, a tree which grows in the warmest parts of South America. It is obtained by boiling the twigs in water, and is a thick brown liquid, of a fragrant odour, and a pungent and bitterish flavour.

Peruvian Bark. [CINCHONA.]

Peruvine. One of the products of the distillation of Peruvian Balsam. Its formula is $C_{18}H_{10}O_2$. It is a light oily fluid.

Pestilence (Lat. pestilentia, from pestis, *a plague*). Any contagious or infectious disease which is endemic or epidemic, and mor[illegible] [PLAGUE.]

Petals (Gr. πέταλον, *a leaf*). In Botany, petals are the divisions of the corolla of a plant. Flowers in which the divisions are all united are called *monopetalous* or *gamopetalous*; those in which they are all separate are *polypetalous*.

Petalism (Gr. πεταλισμός, from πέταλον). In Greek Antiquities, a form of condemnation practised at Syracuse, by which persons considered dangerous to the state were banished for five years, with leave to enjoy their estates and to return after that period. It was, in fact, only another form of the Athenian ostracism [OSTRACISM]; but in the latter the condemnation was written on shells and lasted for ten years, whereas in petalism leaves were employed, and the condemnation lasted only five years.

Petalite (Gr. πέταλον, *a leaf*; from its lamellar structure in one direction). A Swedish mineral of a white, greyish, or greenish colour; often with a tinge of red. It is an anhydrous silicate of alumina, soda, and lithia; sometimes containing as much as five or six per cent. of the latter.

Petalocerans (Gr. πέταλον; κέρας, *a horn*). A tribe of Coleopterous insects, including those which have antennæ terminated by a foliated mass.

Petaloideous (Gr. πέταλον, and εἶδος, *likeness*). A term applied by botanists to any org[illegible]n, not being a petal, the texture and colour of which resemble those of a petal.

Petard (Fr.). In Artillery, an engine formerly much used for breaking down g[illegible], barricades, &c. The petard was formed of gun metal, was bell-shaped, and held from nine to twenty pounds of gunpowder. When about to be used, it was screwed to a thick plank, and suspended before the gate to be burst open. Gunpowder in loose bags, being [illegible]qually effica-

cious, is now employed for the same purpose; but very probably the principle of the petard will again be applied to bursting open gates, &c. by gun-cotton.

Petasus (Gr. πέτασος). A broad-brimmed hat used on journeys by the ancient Greeks; hence a petasus with wings attached to it is the emblem of Hermes.

Petaurist (Gr. πέταυρον, *a perching pole*, probably from πέσαυρος, the Æolic form of μετέωρος, *on high*). The name of a genus of Marsupial animals, termed Petaurus by Shaw, in which the head is rather short, the ears small and hairy; the skin of the flanks is extended between the anterior and posterior limbs, and covered with hair; and the tail is not prehensile. The genus inhabits New South Wales.

Petechiæ (Ital. petecchia). Small red spots produced by the effusion of drops of blood in the skin, immediately under the cuticle. They somewhat resemble flea-bites, and indicate an altered and impure state of the blood.

Peter-pence. The popular name of an impost, otherwise termed *the fee of Rome*, or, in the Anglo-Saxon, *Romescot*: originally a voluntary offering by the faithful to the see of Rome; afterwards a due levied in various amounts from every house or family in a country. Peter-pence were paid in France, Poland, and other realms. In England this tax is recognised by the Norman laws of William the Conqueror. Edward III. discontinued the payment when the popes resided at Avignon; but it was afterwards revived, and finally ceased in the reign of Henry VIII.

Petiole (Lat. petiolus, *a small foot*). In Botany, that portion of a leaf which connects the lamina with the stem of a plant; the footstalk.

Petit Treason. In Law, the offence of murder by a subordinate in certain cases; as by a servant of his master, an ecclesiastic of his prelate, a wife of her husband. But the distinction between this and ordinary murder is now abolished.

Petit-grain. An essential oil obtained from the fruit and leaves of the Seville Orange, *Citrus bigaradia*.

Petitio Principii (Lat. *a demand of the principle*). In Logic, a popular designation for a species of vicious reasoning, which consists in tacitly assuming the proposition to be proved as a premiss of the syllogism by which it is to be proved: vulgo, *begging the question*.

Petition (Lat. petitio). This word signifies generally a supplication preferred by one person to another, who is supposed to be capable of granting the request. The right of the British subject to petition either house of parliament, or the king, was declared by the Bill of Rights. But this Act is not considered as having repealed 13 Ch. II. stat. 1 c. 5, by which it is criminal to solicit or procure the putting the hands of more than twenty persons to a petition for alterations in church or state, unless by consent of three or more justices, or a majority of the grand jury at assizes or sessions, &c.; and repairing to the king or parliament to deliver such petition with above the number of ten persons is also rendered criminal.

Petition. In Equity Jurisprudence, an application in writing addressed to the Lord Chancellor or the Master of the Rolls, in which certain facts are set forth as the ground on which the petitioner rests his prayer for the order and direction of the court.

Petition of Right. In Law, one of the common law methods of obtaining possession or restitution from the crown of real or personal property. The proceedings upon a petition of right have lately been simplified and improved by stat. 23 & 24 Vict. c. 34.

In English History, the Parliamentary declaration, made in the third year of Charles I. (3 Ch. I. c. 1), of the liberties of the people, and assented to by the crown, is commonly termed the Petition of Right.

Petiveriaceæ (Petiveria, one of the genera). A small natural order of monochlamydeous Exogens, belonging to the Sapindal alliance, in which they are known by having apetalous flowers, and a solitary carpel. They are found in the West Indies and tropical America. *Petiveria alliacea*, the Guinea-hen weed of the West Indies, has a strong garlic-like odour, and is excessively acrid; it is used in warm baths to restore motion to paralysed limbs.

Petong. The Chinese white copper; it is an alloy of copper and nickel. [Pakfong.]

Petrels. In Ornithology. [Procellariæ.]

Petrifactions (Lat. petra, *a stone*, and facio, *I make*). A general term by which naturalists designate the conversion of vegetable or animal materials into a stony substance. The word is equivalent to such expressions as *organised fossils*, *organic remains*, &c., which, however, are all liable to exception on the ground of not distinctly explaining what they are meant to define; and though the term *petrifaction* is itself open to censure on the same score, it does not seem that any other word more acceptable to the naturalist has hitherto been found to supersede it.

Petrobrusians. The followers of Peter de Bruys, who, in the twelfth century, declaimed against the vices of the clergy, and gained numerous adherents in the South of France. The exact opinions which he advanced are to be collected only from the assertions of his adversaries, who, at a time when the lower classes throughout Europe were listening eagerly to violent oppugners of the dominant church, did not fail to exaggerate their doctrines to suit their own purposes. Besides the vague charge of Manicheism which was made against most of these sectarians, the imputations cast upon them refer chiefly to their contempt for the ordinances of the church; in which, along with the real abuses of the day, the crucifixes, images, and relics, the ignorant multitude may have included the sacraments and other rites and ceremonies in indiscriminate

abhorrence. A treatise was composed against them by St. Bernard. (Faber's *Albigenses and Waldenses*; Waddington's *Hist. of the Church*, ch. xviii.; Milman's *Latin Christianity*, bk. ix. ch. viii.)

Petroleum (Gr. πέτρα, Lat. petra, *a rock*; oleum, *oil*). *Rock oil.* A liquid bitumen, found in several parts of Europe, in Persia, in the West Indies, and in profuse abundance in the United States and Canada. These oils vary in colour and consistence, and their specific gravity ranges between 0·83 and 0·89. When subjected to fractional distillation, they may be resolved into several hydrocarbons, some of them volatilising on exposure to the air, and leaving scarcely any residue. They have lately become of considerable commercial importance, and are used for burning in lamps, as solvents for caoutchouc and gutta percha, and sometimes as fuel.

Petrolin. A substance obtained by distilling the petroleum of Rangoon; analogous to *paraffin*.

Petromyzon (a word coined from Gr. πέτρος, *a stone*, and μύω, *to be shut*, as of the lips). A genus of cyclostomous fishes, comprising the lampreys, in which the skeleton is imperfectly developed, and the pectoral and ventral fins are absent. Three species are known in England, *P. marinus*, *P. Planeri*, and *P. fluviatilis*. The last is the lampeon, or lamprey, which was formerly caught in great numbers in the Thames; but the fishery has of late much decreased.

Petroselinum (Gr. πετροσέλινον, *rock parsley*). The scientific name of the genus which contains the Parsley, a plant extensively cultivated in our gardens for its use as a potherb, and also for garnishing. The resemblance of the leaves of the common plain-leaved Parsley to those of the poisonous Fool's Parsley (*Æthusa*) has sometimes resulted in serious consequences, when the latter have been accidentally substituted for the former. Hence it is better and safer to use, for all culinary purposes, only the curled-leaved varieties, which are sufficiently common.

Petrosilex (Gr. πέτρον, *a rock*, and Lat. silex, *flint*). A name for Adinole or compact impure Felspar, like that forming rock-masses, or the base of porphyry.

Petty Jury. The jury in criminal cases who try prisoners against whom a true bill has been found by the grand jury.

Petty Larceny. A name applied to the crime of stealing goods to the value of twelve pence or under, in distinction to grand larceny, or the stealing of goods above that value, which was formerly punishable with death. The distinction between grand and petty larceny, and the capital punishment of the former, were both abolished in 1807 (stat. 7 & 8 Geo. IV. c. 29). [Larceny.]

Petty Officers. On Shipboard, a superior class of seamen and artificers. They correspond in rank and (mutatis mutandis) in duties to non-commissioned officers in the army or foremen in civil life.

Petunia (from petun, the Brazilian name of *tobacco*). This name, applied to the present genus in consequence of its near relation to the tobacco plant, represents a popular garden flower of the Solanaceous family, remarkable for its large showy funnel-shaped or salver-shaped flowers, which, originally white or purple, have become varied in the hands of the gardener till they embrace nearly every shade between the two, the colours being either plain, or veined in a variety of ways, or sometimes striped. They rank amongst what are called half-hardy plants, and are great ornaments of the summer flower garden.

Petuntze or **Peh-tun-tse.** A felspathic rock, containing an admixture of quartz, and used in China, when mixed with Kaolin, for making porcelain.

Petworth Marble. A variously coloured limestone, occurring in the weald-clay, and composed of the remains of fresh-water shells. It is also called *Sussex marble*.

Petzite. A variety of Hessite or Telluric silver, in which a part of the silver is replaced by gold. It is found in the mines of Nagyag, and named after Petz, by whom it was analysed.

Peucedanine (Gr. πευκεδανός, *bitter*). A crystallisable principle existing in the root of Hog's Fennel or Sulphur-wort, the *Peucedanum officinale* of botanists.

Peucyl (Gr. πεύκη, *a fir-tree*). A liquid obtained by the action of lime upon the hydrochlorate of oil of turpentine, of which oil it appears to be an isomeric modification. Its formula is $C_{10}H_8$.

Peutingerian Map or **Table** (Ger. Peutinger Tafel; so called from Conrad Peutinger, a native of Augsburg, who was the first to make it generally known). The name given to a map of the roads of the ancient Roman world, written on parchment, and supposed to have been constructed about the time of Alexander Severus, A.D. 226. The original, which is 21 feet in length, and only about one foot in width, is deposited in the imperial library at Vienna; but copies of it are to be found in the *Ptolemy* of Bertius; in Horne, *Orbis Delineatio*; in Bergier, *Traité Historique des Grands Chemins de l'Empire Romain*; and part of it in Murray's *Encyclopædia of Geography*. Combined with the celebrated *Antonine Itinerary*, which it serves admirably to illustrate, though it differs in several essential particulars, the Peutingerian Table may be justly regarded as one of the most valuable bequests of ancient geography to modern times. In this table the high road which traversed the Roman empire in the general direction of east and west is made the first meridian, and to this every part is subjected. The objects along this line are minutely and faithfully exhibited; but of those lying to the north and south of it only some general notion can be conveyed. From the novel and peculiar construction of the table, every object is of course enormously extended in length and reduced in breadth. (Mannert's Introduction

to his edit. of the *Peutingerian Table*, Leipsic 1824.)

Pewter (Old Fr. peutre, Dutch peauter, speauter: Wedgwood). An alloy of tin with lead and antimony frequently bears this name; but the best pewter was formerly made of 12 parts of tin with 1 of antimony, and a very small addition of copper. A fine pewter is made, according to Aiken, by fusing together 100 parts of tin, 8 of antimony, 1 of bismuth, and 4 of copper. The use of these additions to tin is to harden it and preserve its colour; and a good pewter, when clean and polished, has a silvery lustre, and does not readily tarnish. Common pewter, of which measures and pewter pots are made, is an alloy of lead and tin.

Peyer's Glands. Small glandular sacculi peculiar to the mucous membrane of the small intestines. When scattered singly, they are called *glandulæ solitariæ*; when they are aggregated into groups, they are termed *glandulæ agminatæ* or *Peyer's patches*, from the anatomist who first described them. [AGMINATE GLANDS.]

Pezophaps (Gr. πεζός, *pedestrian*, and φάψ, *pigeon*). A genus of extinct columbine birds, found by Leguat in the island of Rodriguez and termed *solitaire*. A few bones have been preserved in the Paris and Glasgow collections, and some have lately reached this country. The figure of Leguat indicates a Struthious affinity in the bird, but the legs and neck were longer, the beak shorter, and the wings, though useless in flight, were somewhat more developed than in *Didus*. Cuvier pointed out its gallinaceous affinities, and Strickland (*Dodo and its Kindred*, 114) remarks that the short arched beak, and the defensive structure of the wings, remind us of the cassowary rather than the dodo, but the osteological evidences indicate that it offers many points of analogy with the dodo and the pigeons.

Pfaffian. A name given by Professor Cayley to certain functions which occur in the solution of the following important problem in the theory of differential equations, well known as Pfaff's problem. To reduce the differential expression,

$$X_1\,dx_1 + X_2\,dx_2 + \;.\;.\;.\;.\; X_{2n}\,dx_{2n},$$

where X_1, X_2 &c . . are each given functions of the $2n$ variables $x_1, x_2 \;.\;.\;.\;.\; x_{2n}$, to the form

$$Y_1\,dy_1 + Y_2\,dy_2 + \;.\;.\;.\;.\; Y_n\,dy_n,$$

where the $Y_1, Y_2 \;.\;.\;.\; Y_n, y_1, y_2 \;.\;.\;.\; y_n$ are again functions of the same $2n$ variables.

Jacobi and Cayley, both of whom have investigated this problem in the pages of Crelle's *Journal*, adopt the symbol $(1, 2, 3, 4, \ldots n)$ to denote a Pfaffian, n being always an even number. Such a function consists of a sum of $1.3.5 \ldots (n-1)$ terms, each of which is a product of $\frac{n}{2}$ factors or *constituents*. The general symbol for a constituent is (i, k), where i and k are *different* numbers, and all are supposed to satisfy the relation

$$(i, k) + (k, i) = 0.$$

This being understood, a Pfaffian is defined by the following relation, which may be regarded as a reduction-formula:

$$(1, 2, 3, 4, \;.\;.\;.\; n-1, n) = (1, 2) \,.\, (3, 4, \;.\;.\;.\; n)$$
$$+ (1, 3) \,.\, (4, 5, \ldots n, 2) + \;..\; (1, n) \,.\, 2, 3, \ldots (n-1).$$

It is important to observe that in the symbols for the Pfaffians of lower order on the right of this equation the numbers are written in cyclic order. The interchange of any two symbols i and k, in fact, is equivalent to a change of sign of the whole Pfaffian, e. g.

$$(1, 2, 3, \;.\;.\;.\; n) = -(2, 1, 3 \;.\;.\;.\;.\; n).$$

The square of every Pfaffian is a skew symmetrical determinant. For instance,

$$(1, 2, 3, 4)^2 = [(1, 2)(3, 4) + (1, 3)(4, 2) + (1, 4)(2, 3)]^2$$

$$\begin{vmatrix} 0 & (1,2) & (1,3) & (1,4) \\ (2,1) & 0 & (2,3) & (2,4) \\ (3,1) & (3,2) & 0 & (3,4) \\ (4,1) & (4,2) & (4,3) & 0 \end{vmatrix}$$

[SKEW SYMMETRICAL DETERMINANT.]

A recent and very complete investigation of Pfaff's problem by Clebsch will be found in Crelle's *Journal*, vols. lx. and lxi. 1862.

Phacolite (Gr. φακός, *a lentil*, and λίθος, *stone*). A hydrated silicate of alumina and lime, with a small quantity of soda, potash, &c. It is a variety of Chabasite occurring in greyish-white or pinkish crystals in cavities of amygdaloidal greenstone at the Giant's Causeway; at Castle Rocks, Magilligan, Derry; also at Leipa in Bohemia; and at New York Island.

Phæacians (Gr. Φαίακες). In the Homeric Mythology, the inhabitants of an island called Scheria, of which Alkinoös, the husband of Arêtê and father of Nausicaâ, is the king. Odysseus, cast on the shore of this island, is found by Nausicaâ, who guides him to her father's house, where he is hospitably entertained; but although Nausicaâ is offered to him in marriage, he says that he must go home to PENELOPÊ, whom he had left twenty years ago; and accordingly the Phæacian ships convey him from Scheria to Ithaca. Much learning has been employed to identify Scheria with the island of Corcyra or Corfu; yet it is but lost labour to seek in earthly geography for the beautiful cloud land where the toiling sun rests for a while before he hastens to his setting in the far west.

Phænogams (Gr. φαίνω, *to show*, and γάμος, *marriage*). One of the two principal groups into which plants are divided; Phænogams being those which produce manifest flowers, and CRYPTOGAMS those which do not. The same distinctions are expressed by the terms *flowering plants* and *flowerless plants*.

Phaethon (Gr. Φαέθων). This word, meaning literally *glittering*, was at first, like Lykios, Delios, and Phœbus, merely a name for the shining sun, as Endymion was an epithet for the sun at his setting; and as long as this was the case, there could manifestly be no personification of these names. But in the measure in which their real meaning was forgotten, the temptation to give to each name its own embodiment became more and more powerful. The process of disintegration in this myth is first shown in the *Odyssey*, xxiii. 246, where Phaethon is the name of one of the horses of the sun; it is next seen as the name of a son of Kephalos (the *head* of the sun), his mother being either Eos, *the morning*, or Hêmera, *the day*. In another version, Phaethon is a son of Helios, *the sun*, and Clymenê, and in fact a mere image of his father's splendour. The disasters caused by the excessive heat of the sun might, therefore, be attributed to him as to one less capable of guiding the fiery horses. Such a being must necessarily lack the strength, though not the spirit, of his father; and that which would be the calm consciousness of power in the parent, would become a rash ambition in the child; and thus would be furnished the groundwork of the legend of Phaethon, who may be wounded and slain, although his father can suffer no hurt. Hence the tale ran that Phaethon, having through the aid of Clymenê obtained possession of the chariot of the sun for one day, lost command of the horses, who, approaching too near the earth, scorched it up; that Zeus, to arrest the mischief, smote Phaethon with a thunderbolt and hurled him from the chariot, and that this evil befell him because, contrary to his express promise, he touched the horses with his whip.

The whole of this myth reappears in the legends of Achilleus and Odysseus. Of the former the image or secondary is Patroclus, the son of Menœtias; of the latter, Telemachus. Mr. Grote has remarked (*History of Greece*, ii. 238) that 'Patroclus has no substantive position; he is the attached friend and second of Achilleus, and nothing else.' Hence he can do nothing until he is expressly sent forth by Achilleus; and when he is sent forth, the Myrmidons stream after him like a pack of wolves. But as Helios warned Phaethon not to whip the horses, so Achilleus strictly charges Patroclus not to drive his chariot in any other path than that which he is bidden keep. The injunction is in each case disobeyed, and Patroclus is consequently slain by Hector, as Phaethon was smitten by the thunderbolt of Zeus.

Of Telemachus, the son of Odysseus and Penelopê, Mr. Grote remarks that he stands to his father in the same relation of dependence as that of Patroclus to Achilleus. Like Patroclus, he can act only on the bidding of his father, and like him he is wounded, while Odysseus sustains no hurt, in the battle with the suitors. His very name suggests a comparison with the myths of Telephus and Telephassa. [Heliadæ.]

Phagedaenic (Gr. φαγέδαινα, from φάγειν, *to eat*). A term applied to ulcers which rapidly corrode and destroy the parts which they attack.

Phalaenopsis (Gr. φάλαινα, *a moth*; ὄψις, *appearance*). One of the finer genera of the ... *P. amabilis*, the Indian Butterfly plant, with its large spreading dead-white flowers, is very handsome, as are also some closely allied plants bearing other specific names. *P. sumatrana* and *Lüddemanniana*, recently introduced, with very different flowers, spotted and barred with chocolate or purple, are also prized for their blossoms; while in *P. Schilleriana*, which has beautiful spreading pinkish flowers, the leaves are also handsomely mottled with grey, thus having both leaves and flowers ornamental. They are all natives of the Indian Archipelago.

Phalanger (Gr. φάλαγξ, *a phalanx*). The name of a genus of Marsupial animals, including those in which the second and third toes of each hind foot are united together as far as the last phalanx in a common cutaneous sheath, and which have a hinder thumb, but no lateral cutaneous parachute.

Phalanges (Gr. φάλαγγες, *battalions*). In Anatomy, the small bones of the fingers and toes.

Phalanges. In Botany, a term applied to bundles of stamens, i.e. when stamens are collected into tufts or groups, as in *Hypericum* and many other plants.

Phalangium or **Shepherd Spider.** The name of a genus of Arachnidans, including those in which all the legs are very long and slender; the tarsi sometimes consisting of more than fifty joints.

Phalanx (Gr. φάλαγξ). The close order of battle, in which the heavy-armed troops of a Grecian army were usually drawn up. There were several different arrangements of the phalanx peculiar to different states; but the most celebrated was that invented by Philip of Macedon. The men stood close together, sometimes with their shields locked, in ranks of several men in depth, displaying in front a row of long-extended spears, or rather a wall of spear-points. The phalanx, whose charge was irresistible in a smooth plain by a lighter body, was found to be overmatched by the combined strength and activity of the Roman legion, which was able to take advantage of any inequality of ground, and charge in flank and rear; and when once an accident offered an opening in the unwieldy mass of the enemy, their confusion was inevitable, and rally hopeless. For a detailed account of the various modifications of the phalanx, see Dr. Smith's *Dictionary of Greek and Roman Antiquities*, s.v. 'Exercitus.'

Phalaris (Gr.). The genus of grasses to which belongs the plant yielding the Canary-seeds of the shops, so much used for feeding small cage-birds. This is the *P. canariensis* of botanists, and with its close ovate panicles and broad keeled glumes is rather ornamental in character.

Phalaris, Epistles of. These letters, ascribed to Phalaris, tyrant of Agrigentum in Sicily, are now known chiefly as the subject of the controversy between Bentley and Boyle, the latter asserting their genuineness, the former denying it on evidence which is overwhelming in its quantity and force. These epistles are first mentioned by Stobæus, who evidently did not share the suspicions openly avowed by Photius. Such forgeries betray themselves chiefly by their glaring anachronisms; but in this case the disguise is so poor as to imply a gross credulity on the part of those who were deceived by it.

Phalarope. The name of a wading bird, with the toes provided with scolloped membranes. The common British species is the grey one (*Phalaropus lobatus*).

Phaleræ (Lat.; Gr. φάλαρα). In Roman Military Antiquities, various kinds of ornaments were so called, chiefly but not exclusively appropriated to the equipment of horse soldiers; it was also applied to the frontlets of the horses themselves. (See the third and twenty-second Mémoires of M. le Beau on the Roman Legion, in *Mém. de l'Acad. des Inscr.* vols. xxviii. and xxxix.)

Phallus (Gr. φαλλός). The emblem of the generative power in nature, carried in solemn procession in the Bacchic orgies. The worship of the Phallus seems to have been universal. It was inveterate among the Jews, the Phallus being the same as the wooden Ashera, set up in the temple itself, and translated in the authorised English version by the word *grove*, for which the women are represented as weaving hangings. The Ashera was placed on the stone altar of Baal; hence it is always stated that the Ashera is hewn down, while the altar on which it stands is overthrown. Among the Hindus the emblem so worshipped is called the LINGA. [MYSTERIES; YONI.]

PHALLUS. In Botany, the name of a genus of Fungi of which *P. impudicus* is one of the most disgusting on account both of its appearance and its smell.

Phanerogamous. [PHÆNOGAMS.]

Phaneroneurans (Gr. φανερός, *manifest*, and νεῦρον, *a nerve*). A name applied by Rudolphi to all those animals in which the nerves are distinctly eliminated.

Phaneros (Gr. φανερός, *open*). A term applied by some odontologists to the teeth, which were erroneously described as exposed dead parts or products, exhaled from the substance of formative bulbs.

Phantascope. The name given by Professor Locke, of the United States, to an apparatus for enabling persons to converge the optical axis of the eyes, or to look *cross-eyed*, and thereby observe certain phenomena of binocular vision. It consists of a flat base-board, with an upright rod at one end bearing two sliding sockets which may be clamped at any height, like those of a retort stand. The upper socket supports a small screen or card having a slit or aperture a quarter of an inch wide and about three inches long, so that both eyes may be applied to it at once, the middle of the aperture being directly over the centre of the base-board. The lower socket bears a moveable screen of pasteboard or thin wood, having an opening of about three inches long, and an inch wide, and so adjusted that its centre is in the same straight line with the centre of the set in the upper card and the centre of the base-board. This screen has an index marked across its middle. In experimenting with the apparatus the observer places an object on the base-board, looks downward through the slit in the upper screen, and slides the lower up or down till the required adjustment is attained. For example, let the letter A be written twice on the base-board, about two and a half inches (the width between the eyes) apart, and in the line of the axis of the apertures of the screens; and suppose the lower screen to be close down to the base-board. On gradually raising this screen, and keeping the eyes directed to the index and not to the letters, each letter will separate and appear double, so that four letters will be seen. As the screen is raised, the two internal images gradually approach and become optically superimposed, or coalesce into one, so that there are only three letters visible, and the middle or superimposed figure is the *phantom* or *image* where there is really no object. On ceasing to look at the index, and directing the eyes on the base-board itself, the phantom figure instantly vanishes.

Phantasmagoria (Gr. φάντασμα, *an appearance*). An optical apparatus, by means of which the images of objects can be magnified or diminished at pleasure, and motion given to them by which a strong illusion is produced. The apparatus is, in fact, nothing more than a magic lantern, in which the images are received on a transparent screen, and the sliders on which the figures are drawn rendered perfectly opaque, except in the figures themselves; so that all light is excluded, excepting that which is transmitted through the image. The lantern, mounted on wheels, is made to recede from or approach to the screen, by which the enlargement or diminution of the image is effected; and in order to preserve distinctness in the picture, the tube in the side of the lantern which carries the lens is, by a particular mechanism, drawn out or pushed in, so as to increase or diminish the distance between the lens and the slider, as the lantern approaches to or recedes from the screen. The phantasmagoria affords a very popular exhibition in lecture rooms. [MAGIC LANTERN.]

Pharbitis. A genus of *Convolvulaceæ* to which is now referred the very handsome flower garden annual commonly called *Convolvulus major*, along with some other species formerly referred with it to the genus *Ipomœa*. The common sort, formerly *Ipomœa purpurea*, is now known as *P. hispida*.

Pharisees. A sect among the Jews, whose name is derived from *pharas*, a Hebrew word signifying *separated* or *set apart*, because they

separated themselves from the rest of the nation, and pretended to the distinction of peculiar holiness. The time of their origin is not accurately determined. They are not mentioned in the Old Testament, but are thought by some to be the same as the Assideans of the books of Maccabees. They are referred to by Josephus as a considerable sect, B.C. 110. Though their rivals the SADDUCEES numbered amongst themselves some men of the highest rank, and those who affected to be conversant with the manners and philosophy of the Greeks and Romans, the Pharisees embraced a greater proportion of the upper classes, and were supported by the admiration of the people and the national feeling in favour of the opinions and habits of their ancestors. Besides being strict interpreters of the written law, their sect superinduced upon it what they called the traditions of the elders, and asserted that Moses delivered an oral law as a supplement to that of the Scriptures. They are frequently reproached in the Gospels with so explaining the latter by the former, as in effect frequently to destroy the validity of the written law. They also observed many outward ceremonies with a studied ostentation which gained for them the veneration of the multitude. They maintained, in opposition to the Sadducees, the popular doctrine of the resurrection, with which they mingled some wild notions touching the transmigration of souls.

Pharmacolite (Gr. φάρμακον, *poison*, and λίθος, *stone*). Native arseniate of lime. It generally occurs in delicate silky fibres or stellated groups of acicular crystals, or in botryoidal, globular and stalactitic forms. It is of a white or greyish colour, but has often a superficial tinge of red or violet, owing to arsenate of cobalt. It is found, amongst other places, at Andreasberg in the Harz, and at Joachimsthal in Bohemia.

Pharmacology (Gr. φάρμακον, *a medicine*, and λόγος). The history of the properties and uses of drugs.

Pharmacopœia (Gr. φαρμακοποιΐα). A book containing directions for the preparation of medicines. Previous to the year 1863, three *Pharmacopœias* were extant in Great Britain, viz. those of the Colleges of Physicians of London, Edinburgh, and Dublin. In 1863 a *British Pharmacopœia* was compiled by the Medical Council of the kingdom, and sanctioned as a substitute for its predecessor.

Pharmacosiderite (Gr. φάρμακον, and σίδηρος, *iron*). Native arseniate of iron. [CUBE-ORE.]

Pharmacy (Gr. φαρμακεία, *the use of medicines*). The branch of knowledge which relates to the medical and chemical history of the different articles of the *Materia Medica*; to the mode of prescribing them, their effects, and composition.

Pharos. Properly the name of an island at the mouth of the harbour of Alexandria, on which a lighthouse was erected; whence it came to be applied as a common name for all lighthouses. [LIGHTHOUSE.]

Pharyngognathi (Gr. φάρυγξ, *the throat*, and γνάθος, *the jaw*). An order of fishes in which the endoskeleton is ossified; the exoskeleton in some as cycloid, in others as ctenoid, scales; the inferior pharyngeal bones coalesced; swim-bladder without duct. The Saurypike and Wrasse form examples of this order.

Pharyngotomy (Gr. φάρυγξ, and τέμνω, *I cut*). The operation of making an external opening into the windpipe, necessary in certain cases of suffocation.

Pharynx (Gr. φάρυγξ). The back part of the mouth; it is somewhat funnel-shaped, attached to the fauces behind the larynx, and terminating in the œsophagus.

Phascolarctos (Gr. φάσκωλος, *a pouch*, and ἄρκτος, *a bear*). The name of a genus of Marsupial animals, of which the koala is the type: its dentition is like that of the kangaroo rats; but it has no tail, and has short hind legs.

Phascolome (Gr. φάσκωλος, and μῦς, *a mouse*). The name of a Marsupial quadruped commonly called the wombat, which has the teeth of a Rodent animal, with the exception of an additional true molar on both sides the jaws. Three living species are known, the *Phascolomys wombatus*, the *P. platyrrhinus*, and the *P. ratifrons*. In latter pliocene tertiary times, a species flourished in Australia as large as an ox, the *P. gigas*.

Phascolotherium (Gr. φάσκωλος, *a pouch*, and θηρίον, *a beast*). A genus of small marsupial insectivorous Mammalia, of which the solitary species *Phascolotherium Bucklandi*, was discovered in the oolitic strata of Stonesfield, Oxfordshire. The inward inflection of the angle of the jaw indicates the marsupial character of this species. The dental formula was:—

$$i.\ \frac{?}{6}\quad c.\ \frac{?-?}{1-1}\quad p.\ \frac{?-?}{3-3}\quad m.\ \frac{?-?}{4-4.}$$

Phase (Gr. φάσις, *appearance*). In Astronomy, this word denotes the different appearances of the moon or planets, according as a greater or smaller portion of the hemisphere illuminated by the sun is visible to the observer. The phases of the moon sometimes denote in particular the new moon, the full moon, and the quarters, these being the principal phases. In the case of the most distant planets the phases are not sufficiently decided to be visible in our instruments.

PHASE. In Natural Philosophy, the particular state, at any given instant, of a phenomenon which undergoes a periodic change, or increases to a given point, and then diminishes in a regular gradation. Thus we speak of the *phase of a tide*, the *phase of an eclipse*, &c.

Phaseolus (Gr. φασήολος, or φάσηλος, *a kidney bean*). A genus of *Leguminosæ*, mostly of climbing habit, the leaves usually with thin largish leaflets, and the flowers remarkable for the keel terminating in a twisted point. There are numerous species, natives of hot climates,

and many of them have long been cultivated as food for man.

The common French or Kidney Bean, or Haricot, *P. vulgaris*, of uncertain origin, though probably Asiatic, is the most generally cultivated in Europe and other temperate climates. The earliest notice we have of Kidney Beans is that given by Pliny, who says the pod is to be eaten with the seed. Several kinds appear to have been known to Gerarde in 1590. Some are termed *runners*, from having twining stems six or eight feet high; others are dwarf and bushy. Of some of these, again, the young green pods, of others the seeds, are eaten; while in a third division both pod and seed may be used until nearly arrived at maturity. In this country the green pods in a young state are most valued, and when properly dressed they are highly esteemed as a wholesome and excellent vegetable. On the Continent the ripe seeds, under the name of *Haricots*, are much used by cooks in the composition of a dish so called, as well as for soups and stews; and in Roman Catholic countries they form the greater part of the food of the people during Lent. When very young, the green pods are frequently preserved as a pickle by themselves; they also form an ingredient in *mixed pickles*.

The Scarlet Runner Bean, *P. multiflorus*, a native of Mexico, is usually considered to be a half-hardy annual, although in reality it is a tender perennial, having tuberous roots, which may be taken up and preserved during winter for planting in spring. The plant is of twining habit, and if supported will climb to the height of eight or ten feet. The pods are pendulous, not quite so long as those of the common Kidney Bean, but broader, rougher, and more succulent. As a culinary vegetable, the Scarlet Runner is much esteemed, particularly in the garden of the cottager. The young green pods are dressed in the same way as those of the Kidney Bean. The roots are narcotic and poisonous.

P. lunatus is so generally cultivated in hot climates, that it is difficult to ascertain its origin. The species is too tender for growth in European climates. In general aspect it is much like the common French Bean; but the pod is flat, short, broad, and somewhat crescent-shaped. *P. Max*, with *P. Mungo*, is much cultivated in India and some parts of Africa, and has narrow, hairy, nearly cylindrical pods. *P. Caracalla*, believed to be a native of Brazil, is often grown under the name of Caracol in the gardens of South America and Southern Europe, and sometimes in those of India, for its large showy and sweet-scented flowers. [VIGNA.]

Phasianidæ (Gr. φασιανός, *a pheasant*). The name of the family of Gallinaceous birds of which the genus *Phasianus* is the type. The pheasant is a native of warmer and drier climates than England, as the Linnæan specific name (*Phasianus colchicus*) implies. Cuvier, accepting the story that it was brought from the banks of the Phasis by the ARGONAUTS, states that it subsequently became diffused over all temperate Europe. It is consequently a matter of difficulty to preserve the species in this country; and were it not for the assistance which the common fowl affords in hatching the eggs of the pheasant, the breed would probably soon become extinct; for although the female produces a great many eggs in the artificial preserves of the wealthy sportsman, yet she soon forsakes the task of incubation, when disturbed, as is too often the case, by the male.

When roused, the pheasant will not unfrequently perch upon the first tree, and seems more intent upon the dogs than the approach of the sportsman: they betray themselves likewise by their habit of crowing or making a chuckling noise when they perch. Foxes destroy many pheasants; and as these are commonly females engaged in incubation, the tendency to diminution of the race from this cause is increased. But the chief loss of the pheasant-breeder is caused by the mortality of the young birds, about the time of changing their nestling feathers, produced by the developement of great numbers of a peculiar species of Entozoon (*Syngamus trachealis*) in the windpipe. This accumulation occasions a difficulty of breathing; and the convulsive attempt to gasp the air, or expel the worms, has occasioned the name of *the gapes* to be given to this disease.

The best remedy is a preventive treatment, by due attention in keeping the young pheasants clean, and by administering plenty and variety of food. When the disease is far advanced, the best remedy is to make the birds breathe air strongly impregnated with fumes of tobacco, carefully watching its effect.

The male pheasant is distinguished, like most *Gallinaceæ*, by its superiority in size and by its brilliancy of plumage from the female; and the dependency of this difference on the generative function is proved by the remarkable instances of assumption on the part of the female of more or less of the male livery, consequent upon the abrogation of that function in her either by age or by injury or disease of the female organs. The food of the pheasant varies according to the season; in winter it consists chiefly of grain and seeds; in spring and summer of insects and nutritive bulbous roots, as that of the crow-foot (*Ranunculus bulbosus*).

The pure breed of *Phasianus colchicus* is distinguished by the absence of the white ring round the neck, and the reddish copper tint of the croup. Another species, from China, with a white ring round the neck, and a greener cast of colour, especially upon the croup, has also been imported and turned wild. It seems to have produced a prolific race of hybrids with the common pheasant.

China produces several other species, which are remarkable for their superb and brilliant plumage; as the golden pheasant (*Ph. pictus*), Amherst's pheasant (*Ph. Amherstii*); both of which have a gorgeous ruff round the neck, and the latter is remarkable for its exceedingly long tail. A like appendage characterises the magnificent Reeves's pheasant (*Ph. Reevesii*).

The silver pheasant (*Ph. nycthemerus*) from China, and the *Phasianus lineatus* from the mountains of Thibet, approach nearer in their carriage to the common fowl. Other species of pheasant (e.g. *Phasianus ignicollis*) have been recently received from Japan.

Pheasant. [PHASIANIDÆ.]

Pheiditia (Gr.). A name given in later times to the Spartan SYSSYTIA. It was probably a corruption of φιλίτια, *love-feasts*, a word answering to the Cretan ἑταιρεῖα, from which they differed in this, that each head of a family contributed a certain portion at his own cost, or on failure was excluded from the public tables. The various dishes of these meals were prescribed by law, and consisted chiefly of the Spartan *black broth* and pork.

Phenakistoscope (Gr. φενακισμός, *illusion*; σκοπέω, *I view*). A philosophical toy, which illustrates the principle of the *persistence* of impressions on the retina of the eye in a very ingenious manner. It is thus described by Sir D. Brewster (*Ency. Brit.* art. 'Optics').

'This instrument was, we believe, originally invented by Dr. Roget, and improved by M. Plateau, at Brussels, and by Mr. Faraday. It consists of a circular disc from six to twelve inches in diameter, with rectilinear apertures on its margin in the direction of its radii. A series of figures, of a rider, for example, leaping a fence, is drawn on the circumference of a circle, parallel to the rim of the disc. The *first* figure represents the rider and horse standing *before* the fence; and the last figure represents them standing *over* the fence, when the leap is completed. Between these two figures there are several others, representing the rider and the horse in various parts of the leap. The observer then stands in front of a looking glass, with the disc in his left hand, attached to a handle, and by a piece of simple mechanism he whirls it rapidly round, looking at its image in the glass through the notches in its margin. He is then surprised to see the horse and his rider actually leaping the fence, as if they were alive, and returning and leaping again as the disc revolves. If we look over the margin of the disc at the reflected picture on the face of the disc, all the figures are effaced, and entirely invisible; but when we look through the notches, we only see the figure of the horse and rider at the instant the notch or aperture passes the eye, so that the picture instantaneously formed on the retina is not obliterated by preceding or subsequent impressions. Hence the eye receives in succession the pictures of the horse and rider in all the attitudes of the leap, which are blended as it were into one action. The apparent velocity with which the horse and rider advance (supposing the disc always to have the same velocity) depends on the proportion between the number of apertures in the margin of the disc, and the number of figures of the horse and rider.'

Phenakite (Gr. φέναξ, *a deceiver*). The rhombohedral Emerald of Mohs. A silicate of glucina, composed of fifty-five per cent. of silica, and forty-five glucina. It occurs in colourless or bright wine-yellow crystals, inclining to red, at Katherinenburg in Siberia, in mica-slate, and also north of Miask; at Tramont in Alsace, and Durango in Mexico. The name has reference to the resemblance to Quartz, for which this mineral may be mistaken.

Phene. One of the chemical synonyms of the hydrocarbon usually called benzole, $C_{12}H_6$. It has also been called *hydride of phenyl*, and is in that case represented by the formula $C_{12}H_5$, H. [BENZOL.]

Phenecin (Gr. φοίνιξ, *purple*). The purple powder which is precipitated when sulphuric solution of indigo is diluted with water. It appears to be a hydrate of indigo.

Phengite. [MUSCOVITE.]

Phengites Marble. [MARBLE.]

Phenic Acid. *Carbolic acid. Phenol.* The hydrated oxide of phenyl. A product obtained chiefly from coal-tar; hence the name, from φαίνω, *I show*. A synonym of CARBOLIC ACID.

Phenomenon (Gr. φαινόμενον, part. of φαίνομαι, *I appear*). In Natural Philosophy, this term is usually applied to those appearances which are produced by the action of the different forces upon matter. Thus the fall of a stone to the earth, the motion of a planet in its orbit, a flash of lightning, the explosion of gun cotton, and the combustion of fuel are all natural phenomena.

Phenyl. A radical hydrocarbon $= C_{12}H_5$.

Phigalian Marble (so called from having been discovered near the site of Phigalia, a town of Arcadia). The name given to a series of sculptures in alto rilievo, now deposited in the British Museum, where they form part of the collection known by the name of the *Elgin Marbles*. They originally formed the fringe round the interior of the cella of the temple dedicated to Apollo Epikouros, or the Protector. They represent the combat of the Centaurs and the Lapithæ, and that of the Greeks and Amazons, resembling both in design and execution the decorations on the Parthenon. As the temple is said to have been built by Ictinus, it is not improbable that these sculptures were designed by Phidias. [PARTHENON; ELGIN MARBLES.]

Philadelphaceæ (Philadelphus, one of the genera). A natural order of epigynous Exogens, belonging to the Grossal alliance. They consist of shrubs, with deciduous leaves, and include *Philadelphus* and *Deutzia*, two of the most ornamental genera of hardy flowering shrubs, the former of which is called Mock Orange or Syringa. The group is particularly marked by its valvate calyx, indefinite stamens, and capsular fruit with axile placentæ and disunited styles. The leaves of *Philadelphus coronarius* taste like cucumbers, and its flowers yield an oil which has been used for adulterating oil of jasmine.

Philanthropinism. A name given in Germany to the system of education on natural principles, as it is termed, which was promoted by Basedow and his friends in the last

century, and mainly founded on the notions of Locke and Rousseau. An institution for the purposes of education, founded under the protection of the duke of Dessau in 1774, was the first so-called Philanthropin. It was dissolved in 1793; and of the different institutions afterwards founded, only one, it is said, has continued to maintain itself. But the labours of the Philanthropinists have no doubt influenced largely the modern system of education.

Philesiaceæ (Philesia, one of the genera). A small natural order of monocotyledons, referred by Lindley to his class of Dictyogens. Their chief distinctive characters reside in their trimerous symmetry, their consolidated carpels, and their parietal placentæ. It comprises *Lapageria rosea*, one of the handsomest of greenhouse climbers, with a hexapetaloid perianth; and *Philesia buxifolia*, the Pepino of Chili, a stiff dwarf shrub, with small box-like leaves, and showy three-petaled flowers. [LAPAGERIA.]

Philibeg or **Filibeg.** [KILT.]

Philippic. The title of several orations of Demosthenes against Philip king of Macedon, the spirit and animosity of which has caused the name to be transferred to similar compositions by other orators. Thus Cicero gave this name to the orations which drove Mark Antony from Rome and compelled the senate to prosecute the war against him after the murder of Julius Cæsar.

Phillipsite. A lime-Harmotome found in white translucent crystals near the Giant's Causeway, and in minute flesh-coloured crystals in amygdaloid at Magee Island, Londonderry, at Vesuvius, &c. It was named after William Phillips the mineralogist.

The name Phillipsite is applied by some French authors to Purple Copper.

Phillyrea (Gr. φιλλυρέα). The name of a genus of evergreen shrubs, belonging to the order *Oleaceæ*, introduced from the region of the Mediterranean, and much used for planting in shrubberies. There are two or three species and several varieties, all of close bushy habit, and with neat persistent foliage. Along with yews and hollies, they were formerly much employed as subjects for the topiary art.

Phillyrin. A bitter crystalline principle contained in the *Phillyrea latifolia*.

Philoctetes (Gr. Φιλοκτήτης). In the Homeric Mythology, Philoctetes is mentioned as a son of Pœas, who, when on his way to Troy with the Achæans, was left at Lemnos, because he had been bitten by a snake, and was suffering from the wound. But round this name has gathered a large amount of floating legend, for which the mere silence of the extant Homeric poems cannot prove a post-Homeric origin. To the remarks already made on this point under PARIS, must be added the caution rendered necessary by the loss of many important poems belonging to the Homeric cycle. [CYCLIC POETS.] These incomplete myths tell us that Philoctetes was bitten by a snake in the island Chrysê, the golden, and near the temple of Athena [MINERVA], the *dawn-goddess*. The wound caused grievous pain, and the hero remained in Lemnos, inactive, like Achilleus at Troy, and Meleagros in Calydon, until Odysseus came to summon him to Ilion, which could not be taken except by the invincible arrows bequeathed to him by Heracles. With these weapons he slew Paris. After the fall of Troy, he journeyed, like the other heroes, to Hesperian or western lands, and was finally slain by Rhodians on the coast of Italy.

The incident of the snake-bite on the foot is repeated in the legend of Eurydicê [ORPHEUS]; while the snake, the serpent of the night, reappears in other myths as the snakes who attack Heracles in his cradle, as Python slain by Apollo, and Fafnir slain by Sigurdr. Philoctetes, like Odysseus, fights, it is true, with poisoned arrows—a custom for which among the historical Greeks there is no evidence; but they are the arrows of Heracles and other solar heroes, all of which are invincible and never miss their mark, and cannot be shot by any but their owners. The idea of the poison was the result of the same confusion which turned Arcas and Callisto into bears [RISHIS, THE SEVEN], and LYCAON and his sons into wolves: the word ἴον, which like Iolê, Iocastê, &c. had expressed the violet colours of dawn, being confused with ἰός, *an arrow*, and hence *poison*, as shooting like a dart.

Philology (Gr. φιλέω, *I love*, and λόγος, *speech*, *discourse*). This word appears to have been used by the ancient writers to designate the whole circle of the sciences, considered, not with respect to their respective subject-matters, but to the language in which they were conveyed. A philologist was one who studied or taught the elegance of diction, as applicable to every branch of human learning; nor can the meaning of the designation be very accurately distinguished from that of the γραμματικός, or grammarian; while sometimes the term *philology* was usurped in a wider sense, so as to comprehend learning in general. After the revival of letters, the word was introduced into modern European languages, but in a much more restricted signification. It then comprehended grammatical criticism and etymology, and some branches of archæology; and as these studies were almost confined to the ancient languages, and other relics of classical antiquity, which alone were then studied in a scientific manner, the only philologists were the learned investigators of the Greek and Latin idioms and literature. Commentaries on ancient authors, etymological works, and glossaries of their language, grammars, &c. were then the class of writings usually denominated philological; and although the field of philology, considered in this sense, is now more extensive, as the modern European and non-European languages have also become the subjects of accurate investigation, it is with this general meaning that the word has chiefly been used by English writers. It

is defined by Johnson, *criticism, grammatical learning.* In this popular sense philology may be said to embrace, 1. Etymology, or the science of the origin of words; 2. Grammar, or the science of the construction of language in general and of individual languages; 3. Literary criticism, or the investigation of merits and demerits in style and diction.

Of late years, however, a new and very extensive province has been added to the domain of philology; viz. the science of language in a more general sense, considered philosophically with respect to the light it throws on the nature of the human intellect and progress of human knowledge; and historically, with reference to the connection between different tongues, and the connection thus indicated between different nations and races. In this sense the term comprehends, 1. *Phonology,* or the knowledge of the sounds of the human voice; which appears to include orthography, or the system to be adopted when we endeavour to render, by our own alphabet, the sounds of a foreign language; 2. *Etymology*; 3. *Ideology,* or the science of the modification of language by grammatical forms, according to the various points of view from which men contemplate the ideas which words are meant to express.

Classical Philology.—By German writers the use of the word *philology* is still not uncommonly restricted to this branch of study. The earliest commentators, lexicographers, and grammarians, whose works we possess, flourished in Greece and Rome at various periods between the Christian era and the fall of the Roman empire. During the middle ages the knowledge of the classical languages, or of the works written in them, ceased to be cultivated as a science. Classical philology was revived about the end of the fourteenth and the beginning of the fifteenth century, chiefly by the labours of various learned Greeks expelled from their own country. In the fifteenth century, Italy was peculiarly animated with a zeal for classical literature. In the following age, the cultivation of this study passed chiefly into the hands of the French, Dutch, and Germans. Under the industrious writers of Holland and Germany it assumed a new form. Less elegant, and pursued in a less poetical spirit than it had been among the Italians, it became a vast and laborious science, exacting the severest industry, and no common ingenuity. During the sixteenth and seventeenth centuries, philologists may be said to have been chiefly occupied in collecting the materials of knowledge: the task of criticism, and of separating the true from the false in classical idiom and diction, began with the seventeenth; and the earliest name in this department of study is perhaps still the most illustrious; that, namely, of Richard Bentley. Since his time, we have had many distinguished classical scholars in our own country, especially in the present century, which has produced the works of Parr, Porson, and Elmsley; but Germany still remains the true nursery of classical research; and the school of Wolf, Heyne, Hermann, and Niebuhr, in that country, has laid down canons of enquiry as to the genuineness and authority of some of the earliest works in the ancient languages, which have imparted a new character to classical criticism in general. [GRAMMAR, COMPARATIVE; LANGUAGE.]

Philology, Biblical. The art of criticising the languages and dialects of the Hebrew and Hebræo-Greek writers in order to elucidate the meaning of the writings of the Old and New Testaments. The HEBREW LANGUAGE, closely akin to the Phœnician, received some modifications, owing to the sojourn of the Israelites in Egypt. How old the book of Job may be, is still a subject of controversy among critics, some of whom suppose that it was originally written in *Arabic* and afterwards translated, while others trace it to a remote period of *Hebrew* literature; but whatever be the date of that book, the PENTATEUCH must ever be considered the basis of the Hebrew as a fixed written language. The institution of the schools of the prophets, under the Judges, no doubt tended to give the polish and poetic character seen in the writings of the age of David and Solomon; but the Hebrew language remained essentially the same down to the conquest of Palestine, first by Shalmaneser (who introduced an Aramæan population in place of the expelled ten tribes); and secondly by Nebuchadnezzar, who (B.C. 588) took Jerusalem and transported the chief members of the two remaining tribes, according to a still prevalent Eastern custom, into his own territories. The Jews, however, during their captivity at Babylon, not only acquired new habits, but received many additions to their language, both of words and idioms; and henceforward they spoke a dialect usually known as the *Hebræo-Aramaic,* bearing nearly the same analogy to the Hebrew that the modern Italian bears to the Latin. In the later historical writers traces may be discovered of this corruption. The prophecies of Haggai, Zechariah, and Malachi, also, though very pure, present a few instances of Chaldeism; but the new dialect is most of all perceptible in the Targums and other commentaries by which alone the Scriptures could be made intelligible to the common people. Schultens, Rosenmüller, the elder Michaelis, Bishops Louth, Horsley, and Colenso, Gesenius, Ewald, and Professor Lee have endeavoured to elucidate the history of the Hebrew language; and the best editions of the Hebrew Scriptures are by Kennicott and De Rossi. After the cessation of Hebrew prophecy on the death of Malachi, about 400 years B.C., the Aramæan dialect prevailed more or less, owing to the adherence of the Jews to their national language, down to the capture of Jerusalem by Titus. The conquests of Alexander, however, had an undoubted influence over the learned castes, who gradually became acquainted with the Greek language; and accordingly (B.C. 280) Ptolemy Phil-

adelphus invited five Jewish scribes to Alexandria for the purpose of translating the Pentateuch into Greek. Some years afterwards the other books of the Old Testament were translated by different hands; but the name SEPTUAGINT is a misnomer; and the story connected with it (resting wholly on the very questionable authority of Plutarch and Diodorus Siculus) is unworthy of credit. The work, however, is written in good Macedonian Greek (κοινὴ διάλεκτος), with a few Hebrew admixtures; and hence the Septuagint should be studied in connection with the New Testament, which presents similar features. In the time of Christ the Aramaic (as the Gospels furnish abundant proof) was the vulgar language of Palestine; and even Galilee had a separate though cognate dialect. (Luke xxii. 59; Acts ii. 7.) At this time the Greek language, so far as the regions west of Palestine were concerned, was the great medium of communication. Hence the Gospels and other Christian books were written in this language; and thus arose those peculiarities of diction, Hebrew expressions, &c., which mark the Hellenistic writings of the New Testament. This, indeed, constitutes the science of Biblical philology; and in this work the labours of Wetstein, Mill, Griesbach, and more recently of Scholz, Lachmann, and Tischendorf, have been employed in producing a sound text from the examination of the best MSS.

Philosopher's Stone. [ALCHEMY.]

Philosophic Candle. An inflamed jet of hydrogen gas.

Philosophic Wool. Oxide of zinc formed during the combustion of the metal, when it floats about in white flocks in the air. It has also been called *nihil album* and *pompholix*.

Philosophy (Gr. φιλέω, *I love*, and σοφία, *wisdom*). In common acceptation, a general term, signifying the sum total of systematic human knowledge. It is commonly divided into three grand departments; metaphysics, physics, and ethics. If we include in the first logic, this may be regarded as a complete distribution of science, properly so called. The first has for its object those truths which go beyond mere experience; as the nature of being, of God, of the soul, &c., as they are in themselves, or as they are apprehended by us. [METAPHYSICS.] The second relates to objects as they are in nature, as subject to the relation of cause and effect. The third contemplates human actions as they *ought* to be, not merely as they are; and takes account of the ideas of duty, freedom, responsibility, and the like—of all, in short, which constitutes the distinction between *an action* and *an event*.

This word was first used by the Pythagoreans, and adopted from them by Socrates, who considered himself a lover or seeker of wisdom only; in distinction from a *sophist*, or one who conceives himself to be in the possession or exercise of wisdom.

But the tendency of modern thought is more and more to restrict the term to that system of inductive philosophy (as opposed to all deductive systems) which Lord Bacon is held, perhaps not altogether correctly, to have introduced. But whether he first enunciated the principle, or whether Socrates acted upon it when he insisted that ethics alone furnished a real basis for science, inductive philosophy may be described as a system which receives no evidence but that of fact, and owns no authority but that which is derived from experience. All subjects, therefore, it regards as open questions; and all prejudices or prepossessions which may interfere with a dispassionate analysis it utterly disclaims. This process of rejection, which Lord Bacon held to be an indispensable condition for the attainment of truth (i.e. the truth of facts), he calls the *purification of the intellect*; and to it we owe all those results of modern science, which, while enormously extending the empire of man, establish continually on a firmer footing the dominion of an unbroken law, admitting no interruptions and excluding altogether any ideas of arbitrary interference. [LOGIC.]

Many valuable histories of ehilosophy have appeared of late years, especially in Germany. The most celebrated are those of Brucker, Tennemann, and Ritter. A sketch of the history of philosophy, written by the la e Mr. Dugald Stewart, originally prefixed to the *Encyclopædia Britannica*, is now printed in a separate volume.

Philter (Gr. φίλτρον). A drug or preparation supposed by the ancients to have the power of exciting love. Nothing certain is known respecting the composition of these potions; but their operation was so violent that many persons lost their lives and their reason by their means. The Thessalian philters were in the highest celebrity. (Juv. vi. 610.)

Philydraceæ (Philydrum, one of the genera). A small group of petaloid monocotyledons, nearly allied to the *Xyridaceæ*, differing chiefly in wanting an outer perianth, in the inner perianth being two-leaved, in having three stamens, two of which are abortive, and in the large embryo lying in the axis of the albumen. They are natives of New Holland, Cochin China, and China.

Philyra (Gr. φιλύρα). In Mythology, one of the Oceanides, and mother of the centaur Cheiron.

Phlebitis (Gr. φλέψ, *a vein*). Inflammation of a vein.

Phlebolite (Gr. φλέψ, and λίθος, *a stone*). A venous calculus, commonly called *vein-stones*. Very small concretions have sometimes been found in certain veins, varying in size from a pin's head to that of a pea. They consist chiefly of carbonate and phosphate of lime and animal matter.

Phlebotomy (Gr. φλεβοτομία). The operation of opening a vein for the purpose of taking away blood.

Phlegethon (Gr. φλεγέθων, *burning*). The name of one of the rivers of HADES, commonly called Pyriphlegethon. [COCYTUS.]

Phlegmasiæ (Gr. φλεγμασία, from φλέγω, *I burn*). Inflammatory diseases. The term *phlegmasia dolens* has been applied to a peculiar inflammatory condition of the leg, which sometimes occurs in females soon after delivery.

Phleum (Gr. φλέως). A useful genus of agricultural grasses, remarkable for the close cylindrical form of the spike-like panicles. *P. pratense* is the Timothy or Cat's-tail grass, one of the earliest and most productive of our British species, and on that account freely introduced into pasture land.

Phlogiston (Gr. from φλογίζω, *I set on fire*). An imaginary principle by which Stahl and the chemists of his school accounted for the phenomena of combustion; the matter of fire fixed in combustible bodies.

Phlogolite or **Phlogopite** (Gr. φλογωπός, *fiery-looking*). A variety of magnesian Mica.

Phlóridzin (a word coined from Gr. φλοιός, *bark*, and ῥίζα, *root*). A white crystalline substance obtained from the bark of the roots of apple, pear, cherry, and plum trees, giving to it its bitter astringency. Its composition is represented as $C_{42}H_{24}O_{20} + 4HO$. Acids, aided by heat, resolve it into glucose and *phloretine*. By the joint action of oxygen and ammonia it is converted into a gum-like substance, which has been called *phlorizéin*.

Phlox (Gr. *a flame*). A favourite genus of garden flowers, chiefly North American, and for the most part herbaceous perennials. As usually happens with popular flowers, the species themselves, once cultivated for their own sakes, have given way before the more showy hybridised varieties, and at the present day are rarely met with, the garden Phloxes being all productions of the florist, and of a most ornamental character. A few well-marked dwarf-habited sorts are still grown as rock plants; and *P. Drummondii*, which has sported into a variety of beautiful colours, is one of the most showy of cultivated annuals.

Phlyctænæ (Gr. φλύκταινα, *a pustule*). Bladders formed on the skin during the process of mortification. The cuticle is raised by effused serum, which has a sanguineous colour, and gases are subsequently generated by putrefaction, so that the phlyctænæ contain both fluid and gases. [Gangrene.]

Phlyzacium (Gr. φλύζειν, *to bubble*). A pustule upon the skin.

Phoca (Lat.; Gr. φώκη). [Seal.]

Phocaceans. *Phocacea* or Seal Tribe. The name of the family of carnivorous and amphibious Mammals of which the seal (*Phoca*) is the type. [Seal.]

Phocæna (Gr. φώκαινα, *a porpoise*). A subgenus of dolphins, distinguished by the absence of the beak-like prolongation of the jaws.

Phocenin. A peculiar fatty matter contained in the oil of the porpoise (*Delphinum*). When saponified, it yields a volatile odorous acid, called *phocenic acid*.

Phœbus (Gr. φοῖβος, *brilliant*). A name given to Apollo as the god of light. The epithet Delios, supposed to point to the island of Delos, denoted his birth in the *bright* (δῆλος) land, as the name Lykêgenês described his birth in Lykia, the region of *light*. [Lycaon.] The island Delos was also called Ortygia, but this word was derived from ὄρτυξ, *a quail*, in Sanscrit vartika, the bird of spring, and hence signified the quail land, the East. (Max Müller, *Lectures on Language*, second series, p. 507.) [Œdipus; Paris; Phaethon; Telephassa.]

Phœnicin (Gr. φοίνιξ, *purple*). A purple substance obtained by the action of sulphuric acid on indigo.

Phœnicochroite (Gr. φοίνιξ, *purple*, and χροιά, *colour*). A native chromate of lead, from Beresow in Siberia.

Phœnicopterus (Gr. φοινικόπτερος, *red-feathered*). The generic name of the flamingo: also a term applied to other animals which have red wings, as the *Bombycilla phœnicoptera*.

Phœnix (Gr. φοίνιξ). In Astronomy, one of the modern constellations in the southern hemisphere.

Phœnix. In Botany, a genus of pinnate-leaved Palms, of which about a dozen species are known, chiefly found in Northern Africa and tropical Asia. One of the species, *P. dactylifera*, the Date Palm, is cultivated in immense quantities all over the northern part of Africa, and more sparingly in Western Asia and Southern Europe. In some of these countries, its fruit, though known to us only as an article of luxury, affords the principal food of a large proportion of the inhabitants, and of the various domestic animals. The tree usually grows about sixty or eighty feet high, and lives to a great age; trees of from one to two hundred years old continuing to produce their annual crop of dates. Many varieties are recognised by the Arabs, and distinguished by different names according to their shape, size, quality, and time of ripening. The fruit, however, is not the only valuable part of this widely dispersed tree, for, as with the cocoa-nut palm, nearly every part is applied to some useful purpose. The huts of the poorer classes are entirely constructed of its leaves; the fibre (*lif*) surrounding the bases of their stalks is used for making ropes and coarse cloth, and the stalks themselves for crates, baskets, brooms, walking-sticks, &c.; of the wood are built substantial houses; the heart of young leaves is eaten as a vegetable; the sap affords an intoxicating beverage (*lagbi*), to obtain which the tree is destroyed; and even the hard and apparently useless stones are ground into food for camels.

P. sylvestris, called the Wild Date, is supposed by some to be the parent of the cultivated Date. It is common all over India, and, like the last, attains a considerable height. Large quantities of toddy or palm-wine are obtained from it; but the Asiatics, more skilful than the Africans, procure it by merely cutting off the young flower-spike, by which means they do not destroy the tree. Date-sugar, extensively used in India, is made by simply boiling the toddy.

Phœnix. In the Homeric Mythology, the

father of EUROPA, while other poems represent him as her sister. The Phœnix who is mentioned in the *Iliad* as teaching Achilleus in his early youth is a son of Amyntor. He took part in the Calydonian hunt, and when his father had put out his eyes, his sight was restored by Cheiron the CENTAUR. But the point of greatest interest in the legends of Phœnix is his appearance, in the ninth book of the *Iliad*, as a mediator before Achilleus on behalf of the Achæans. The means which he adopts for softening his anger is a recital of the tale of MELEAGROS, a hero whose story is but another version of that of Achilleus. [MYTHOLOGY, COMPARATIVE.] The name Phœnix also, as expressive of colour, suggests a comparison with the many names in solar legends, which have a similar force, as Iolê, Iocastê, Iamos, Iobates, Augê, Pyrrha, &c.

According to Herodotus, the phœnix was a marvellous bird, which the Egyptians regarded as the emblem of immortality. In later legends the bird was described as of the size of an eagle, her head finely crested, her body covered with a beautiful plumage, and her eyes sparkling like stars. She was said to live 500 or 600 years in the wilderness, when she built for herself a funeral pile of wood and aromatic gums, which she lighted with the fanning of her wings, and emerged from the flames with a new life. In the account of Herodotus (ii. 73) nothing is said of the resurrection of the phœnix; while other versions speak of a worm, which, proceeding from the body of the dead bird, was developed into another phœnix. With these tales may be compared the myths of the Persian bird Simorg, and the Indian Semendar.

Four periods are mentioned by ancient writers as having been marked by the appearance of the phœnix. The first was in the reign of Sesostris; the second in that of Amasis; the third in that of Ptolemy III. king of Egypt; and the fourth in that of Tiberius. By early Christian writers, as in the epistle to the Corinthians which bears the name of Clement, it was frequently brought forward as an illustration of the doctrine of the resurrection (Spanheim, *De Usu et Præstantia Numismatum*, diss. v. c. xiii.), and it appears on the coins of several Roman emperors, sometimes as a symbol of their own apotheosis, sometimes as an emblem of the renovation of the world under their beneficent rule. (Ovid, *Met.* xv. 391; Pliny, *Hist. Nat.* x. 2; Tacitus, *Annal.* vi. 28. Besides these, the reader may consult, in the third volume of Wernsdorf, *Poetæ Minores*, to which the editor has prefixed a learned introduction, the poem *De Phœnice*, which is usually attributed to Lactantius. See also Metral's work, *Le Phœnix, ou l'Oiseau du Soleil*, Paris 1824; and Sir G. C. Lewis *On the Astronomy of the Ancients*, p. 283.)

Pholadeans (Gr. φωλεός, *a hole*). The family of Lamellibranchiate Bivalves of which the genus *Pholas* is the type; they are remarkable for the *hiding places* which they excavate for themselves in rocks and clay.

Pholarite (Gr. φολίς, *a scale*). A hydrated silicate of alumina, resembling Kaolin in composition. It is formed of small convex scales, which are pure white and have a pearly lustre. It is soft to the touch and friable between the fingers. It is of frequent occurrence in the crevices of nodules of coal-measure clay-ironstone, in Coalbrook Dale. It is also found in the coal mines of France, Belgium, and Pennsylvania; at Schemnitz in Hungary, and at Naxos (with emery).

Pholidogaster (Gr. φολίς, and γαστήρ, *belly*). A genus of Ganocephalous Reptiles discovered by Prof. Huxley in the Gilmerton coalfield, near Edinburgh. In this genus the vertebral centra were well ossified, as in the Triassic *Labyrinthodon*, but not as in the *Archegosaurus* of the carboniferous strata. The specimen on which the genus was founded was thought for many years to be a fish; and from its general ichthyoïd similarity, Professor Huxley names it *Pholidogaster pisciformis*.

Phonetic Spelling (Gr. φωνή, *sound*). Much labour has been spent of late years in attempts to introduce a system of phonetic spelling applicable to all languages. Some books and newspapers have been published in this new character, to the elaboration of which Mr. Pitman has devoted his life. Of this Phonetic Reform, Professor Max Müller says that, 'if our spelling followed the pronunciation of words, it would in reality be of greater help to the critical student of language than the present uncertain and unscientific mode of writing.' (*Lectures on Language*, 2nd series, p. 100.) On the other hand, it is argued that 'although under such a system each man's language might remain intelligible to himself, that of others would, for the philologist at least, become a mere trackless thicket. Every consonantal and vocal change in dialects is subject to strict law. The occurrence of a single letter, which may not alter the sound, may determine that a word shall or shall not be identified with another. The removal of this letter would blot out the evidence of its growth. There is no difference in pronunciation, we are told, between the French *mai*, the month of May, the Latin *maius*; *mais*, but, the Latin *magis*; mes, the plural of *my*, the Latin *mei*; and *la maie*, a trough, perhaps the Latin mactra: or between *sang*, blood, *sanguis*, *cent*, a hundred, *centum*, and *sans*, without, *sine*; *sent*, he feels, *sentit*, *s'en*, in *il s'en va*, *inde*. Strike out these traces of their origin still preserved in their spelling, and who would have either time or energy enough to master the history of this single language?' (*Westminster Review*, January 1865, p. 45.) [LANGUAGE.]

Phonetic Writing. That writing in which the signs used represent sounds; in opposition to *ideographic*, in which they represent objects, or symbolically denote abstract ideas, as in the figurative part of the Egyptian hieroglyphics. The signs representing sounds are usually arbitrary, or at least have

become so in process of time; as in the ancient Roman alphabet, of which the letters are for the most part derived from the Hebrew or Phœnician, in which languages they may have originally had a symbolical character. But, in a species of phonetic writing which is intermixed with the figurative hieroglyphics in Egyptian inscriptions, every letter is denoted by a figure representing some object, the name of which begins with that letter. [HIEROGLYPHICS.]

Phonics (Gr. φωνή). The doctrine of sound: the same as *acoustics*. [SOUND.] As sound, like light, is subject to certain laws of reflection and refraction, the science, like that of light, may be treated under three heads; namely, direct, reflected, and refracted sound. In allusion to the corresponding branches of optics, these have been denominated *phonics*, *cataphonics*, and *diaphonics*.

Phonolite (Gr. φωνή, and λίθος, *a stone*). A species of compact basalt, sonorous when struck.

Phorcos (Gr.). In the Homeric Mythology, an old man who rules over the sea. In the Hesiodic *Theogony* (270), he is the father of the three Graiæ, who were grey-haired from their birth, and had between them a single eye and a single tooth. Their abode was in the far west, in a dim twilight land, scarcely penetrated by the rays of the sun. Here PERSEUS, having seized their single eye, compelled them to guide him to the nymphs of the ocean-stream. The idea of the Graiæ manifestly grew out of mythical phrases which spoke of the dusky gloaming, as distinguished from the black night in which the GORGONS had their dwelling.

Phormium (Gr. φορμός, *a wicker basket*). The genus of the New Zealand Flax, *P. tenax*, a stout-growing herb forming large tufts of sword-shaped leaves, and in its distribution confined to New Zealand and Norfolk Island. The leaves, which in some of its forms are from five to six feet long, contain a large quantity of strong useful fibre, to which the name of New Zealand Flax has been given. This material has long been in common use among the natives for making various articles of clothing, string, nets, &c.; and since the colonisation of that country attempts have from time to time been made to render it an article of export, but hitherto without much success, the cost of preparation, owing to the presence of a viscid gummy matter in the leaves, being too great to allow of a remunerative profit.

Phoronomia or **Phoronomics** (a word coined from Gr. φέρω, *I bear*, and νόμος, *law*). This term has been sometimes used to denote the science of motion. In this sense it was employed by Hermann, a mathematician who flourished in the beginning of the eighteenth century, in a work entitled *Phoronomia, seu de Viribus et Motibus Corporum Solidorum et Liquidorum* (Amstel. 1716), and of great merit for the time in which it appeared. The term *dynamics* being now employed generally to signify the doctrine of moving bodies, the term *phoronomics* is never used in modern scientific works.

Phosgene Gas (Gr. φῶς, *light*, and γίγνομαι, *I produce*). A compound of chlorine and carbonic oxide, made by exposing equal measures of those gases to the sunshine, or to bright daylight. They will not unite in the dark.

Phosgenite. Native chloro-carbonate of lead. [CROMFORDITE.]

Phosphamides. Combinations of phosphorus with oxygen and the elements of ammonia.

Phosphates. The salts formed by the combination of phosphoric acid with bases.

Phosphides, Phosphurets. Combinations of phosphorus with metals or hydrogen.

Phosphites. The salts resulting from the combination of *phosphorous acid* with bases.

Phosphocerite. A mineral identical in composition with Cryptolite; from which, however, it differs in form, occurring in colourless or sulphur-yellow octahedrons and four-sided prisms with quadrilateral terminations. It forms about a thousandth part of the cobalt ore of Johannisberg in Sweden.

Phosphorescence. The emission of light by substances at common temperatures, or below a red heat.

Phosphorescent Animals. Those species are so called which have the faculty of emitting a luminous fluid. They are much more numerous than the electric animals; belonging to most of the Invertebrate classes, and frequently rendering vast tracts of the ocean luminous by their prodigious numbers. The glow-worm (*Lampyris*), the phosphorescent sea-pen (*Pennatula phosphorea*), and the brilliant pyrosome (*Pyrosoma atlanticum*), are among the most remarkable of these animals.

Phosphoric Acid. A compound of 1 atom of phosphorus = 32, with 5 of oxygen, = 40 (PO_5). Its equivalent, therefore, is 72. [PHOSPHORUS.]

Phosphorite. A name given to massive native phosphate of lime. [APATITE.]

Phosphorochalcite. A native hydrated phosphate of copper, occurring in minute rhombic crystals, also in fibrous and earthy masses of an emerald or verdigris green colour, but often blackish-green superficially, near Rheinbreitenbach on the Rhine, and also at Nischne Taguilsk, in the Ural, and in Hungary.

Phosphorus (Gr. φωσφόρος, *bringing light*). Phosphorus, so termed from its property of shining in the dark, occurs in the three kingdoms of nature, but most abundantly as a component of the bones and urine of animals: it is generally present as phosphoric acid, combined with various bases. Although phosphorus is found in certain phosphates in the mineral kingdom, it is, like carbon and sulphur, a most important constituent of organic matter. It exists in albumen and fibrin, and in the brain, blood, milk, and other secretions. It is found in the seeds and husks of the cerealia, and in numerous

esculent roots. There is no substance which yields it more abundantly than bone, and from this source it is now generally obtained.

Phosphorus was discovered in 1669, by Brandt, a merchant of Hamburg, in the solid residue of urine, but no practical use was made of the discovery until a century later, when a process for preparing it from bone was first made public by Scheele and Gahn. It is now obtained as follows.

On twenty parts of calcined bone, ground to a fine powder, pour eight of sulphuric acid, previously diluted with forty parts of water. These materials are well stirred together for about six hours, steam being let into the mixture to promote the chemical changes. The whole is then put into a conical bag of linen to separate the clear liquor, which is a solution of superphosphate of lime, and is decanted and boiled to dryness. A white mass remains, which when fused forms what is called *glass of phosphorus*. It yields phosphorus when distilled at a white heat with one-fourth of its weight of charcoal.

The phosphorus obtained by the first distillation is commonly of a red or brown colour, owing to impurities. It is melted in a solution of ammonia, and is bleached by heating it in a mixture of bichromate of potash and sulphuric acid. After this it is again melted, and strained through chamois leather. The mechanical impurities are thus separated, and it is finally cast into sticks. This substance is now manufactured in tons, chiefly for the purpose of making lucifer-matches. According to Mr. Gore, about six tons are annually consumed in this country in the match manufacture, and one pound will suffice for 600,000 matches. This manufacture is, however, conducted on a larger scale abroad.

When pure, phosphorus is tasteless, colourless, translucent, sectile, and flexible at common temperatures, but brittle at 32°. Exposed to air, it exhales luminous fumes, having a peculiar odour, distantly resembling that of garlic, and ozone is at the same time produced. Its specific gravity is 1·826. It is insoluble in water, but dissolved sparingly by alcohol, ether, the oils, naphtha (and other liquid hydrocarbons), and very abundantly by sulphide of carbon. When air is excluded, phosphorus melts at about 110°, and if suddenly cooled to 32°, after having been heated to 140°, it sometimes becomes black. At from 550° to 570°, in close vessels, it boils and evaporates in the form of colourless vapour, the density of which, according to Dumas, is 4·355. Phosphorus is a formidable poison; a few grains are sufficient to destroy life, and the vapour when breathed (as in lucifer-match making) produces caries and necrosis of the jaws, with wasting disease.

There are some peculiar circumstances connected with the luminosity and inflammability of phosphorus. When exposed to humid air, it shines with a pale blue light. This arises from slow combustion, attended by the production of phosphorous acid (PO_3) and ozone. In pure oxygen, phosphorus is not luminous until heated to between 70° and 80°, above which temperature it inflames, and then burns with solar splendour. Graham has shown that the slow combustion of phosphorus in air is prevented by small additions of certain gases and vapours, such as sulphurous acid, sulphuretted hydrogen, and of olefiant gas; the vapours of sulphide of carbon, ether, kreasote, naphtha, and oil of turpentine. Phosphorus easily takes fire by the heat of the hand and by slight friction; it requires, therefore, to be handled with the utmost caution. Owing to the superficial formation of phosphorous and phosphoric acids, when it burns imperfectly at low temperatures, its further combustion is often prevented: thus, in rubbing a fragment of phosphorus between two pieces of brown paper, a momentary combustion ensues, and it often requires considerable friction to cause it again to inflame. For the same reason it is difficult to light a piece of paper by the flame of phosphorus, the paper becoming covered and protected by the acid produced. So also a small piece of phosphorus may be fused by the gradual application of heat, but it will not inflame until the surface is disturbed by touching it with a wire. A fragment gently heated on writing paper may be melted and consumed without igniting the paper. When in brilliant combustion in the air, phosphorus evolves copious fumes of phosphoric acid (PO_5): its flame is intensely luminous, and nearly white. If heated in a confined portion of air, it enters into less perfect combustion; and an oxide, or red solid, less fusible than phosphorus, is produced. The different products of the combustion of phosphorus are well shown by heating a fragment of it placed near the centre of a thin glass tube of about a fourth of an inch in diameter, and three or four feet long, and then gently driving a current of air through the tube; the fixed and volatile acids, and the red oxide, are in this way distinctly separated.

Allotropic or *Amorphous Phosphorus*.—As a result of exposure to heat or light, phosphorus sometimes acquires a red colour, and this red substance is allotropic or amorphous phosphorus. Schrötter made the discovery of this variety of phosphorus in 1848. He obtained it by distilling phosphorus in an atmosphere of nitrogen or carbonic acid, at a temperature between 460° and 480°. In this case, a part of the phosphorus assumes the amorphous or red condition. To separate the common from the amorphous kind, sulphide of carbon is employed, which dissolves common phosphorus but leaves the allotropic variety in the form of a brownish-red powder. For commercial purposes, allotropic phosphorus is made by heating phosphorus under water in an air-tight cast-iron boiler to a temperature of 450°. A quantity of about 200 pounds of ordinary phosphorus is thus kept heated for three or four weeks. When the vessel is opened, the phosphorus presents itself as a hard, red, brittle substance.

Amorphous phosphorus has no odour. When dry, it undergoes no change in air: it is not luminous, and produces no ozone. It does not take fire under a temperature of 500°; and although it is only phosphorus in an altered molecular condition, it has no poisonous properties.

It has already been stated that the product of the perfect combustion of phosphorus is anhydrous *phosphoric acid* (PO_5), a fusible substance, very soluble in water, intensely sour, and having some remarkable peculiarities in reference to its states of hydration and its combination with salifiable bases, forming monobasic, bibasic, and tribasic salts, distinguished as *metaphosphates*, *pyrophosphates*, and common (or tribasic) phosphates. There are two other acids of phosphorus; namely, the *phosphorous acid* (H_2PHO_3) and the *hypophosphorous acid* (HPH_2O_4). When phosphorus is boiled in a solution of caustic potash, a gas is evolved, which is remarkable for its spontaneous inflammability; each bubble, as it rises through the water, taking fire upon the surface, and producing a beautiful ring of smoke. This gas is commonly called *phosphuretted hydrogen*; it consists chiefly of the terhydride of phosphorus (PH_3), with a little of the vapour of another compound (PH_2). Phosphorus may be made to combine with the greater number of the metals, forming compounds called *phosphurets* or *phosphides*.

Photicite or **Photizite** (Gr. φῶς, *light*). A mixture of silicate and carbonate of manganese, found near Rübeland in the Harz. It has often a fibrous texture, and is of various tints of red, green, and grey, which become darker on exposure.

Photo-lithography. [PHOTOZINCOGRAPHY.]

Photo-metallography. [PHOTOGLYPHIC ENGRAVING.]

Photogalvanography. A process (now little used) for transferring drawings &c. to metal by means of light. A plate is rendered sensitive by gelatine and bichromate of potash [PHOTOGLYPHIC ENGRAVING], and exposed to light in contact with the photograph or drawing. A mould is then taken from this plate after exposure, and an electrotype impression taken from the mould. This electrotype is used for printing. The process is tedious, requiring some weeks for its completion.

Photogen or **Paraffin Oil.** The oily product obtained by the distillation of various shales and cannels, and especially from the Boghead cannel coal. It consists of various liquid compounds of carbon and hydrogen, holding paraffin in solution. It is largely used as a source of light, for which purpose it possesses great advantages. One gallon of paraffin oil yields light equal to that of 22·9 lbs. of sperm candles, and produces (when burnt with a good supply of air) far less atmospheric deterioration than the latter. The oils distilled from the natural petroleums are frequently compounded with photogen, which they resemble greatly in properties, but generally contain, unless specially purified, more volatile constituents. [OILS; PARAFFIN.]

Photogenic Drawing. [PHOTOGRAPHY.]

Photoglyphic Engraving. An improved process invented by Mr. Fox Talbot, by which, through the agency of light, photographic and other transparent designs can be transferred to metal plates. It is performed as follows: A solution of one part of gelatine in 40 parts of water is mixed with 4 parts of a saturated solution of bichromate of potash, and the mixture is poured over the steel or copper plates, and allowed to dry. It is then exposed, in contact with the object which it is desired to copy, in a printing frame, to the action of light for several minutes. After this exposure to light, a little finely powdered copal is strewed over the surface, and melted by the aid of heat. The design is now etched in by means of hydrochloric acid, saturated with peroxide of iron, and diluted with water. This attacks only the parts unacted on by light. When a sufficient depth has been attained, the etching liquid is washed off, and the plate cleaned with soft whiting. It can then be employed for printing.

Photography (Gr. φῶς, *light*, and γράφω, *I write or grave*). Under the general term *photography* we now include all those processes for the production of pictures, which depend upon the chemical influences of solar or other intensely luminous radiations. As the name implies, these pictorial representations of external objects were to result from the action of LIGHT—*the* *power of the sun*; recent invest that the most luminous portion of the 's light is quite powerless to produce the changes upon which photography depends, and that these changes are produced to some extent by the feebly luminous blue and violet rays of the spectrum, but chiefly by other rays which are absolutely dark and invisible.

Mr. Wedgwood, the celebrated potter, was the first who attempted to produce pictures by the sunshine; he was aided in his investigations by Sir Humphry Davy, but the results were not satisfactory, since no means of rendering the pictures permanent were then discovered. M. Niepce, of Châlons-sur-Saone, pursuing investigations of the same kind, discovered that all the resins underwent a change by exposure to sunshine, and by spreading solutions of them over glass and metal plates, and placing them in the camera obscura, images were slowly impressed upon these prepared surfaces; this process was called by the inventor HELIOGRAPHY. M. Niepce associated himself with M. Daguerre, but he died before the discovery of the very beautiful process, the *daguerreotype*, which consisted in forming a film of iodide of silver upon plated copper, exposing this film to the image of the camera, and then to the vapour of mercury, the latter condensed upon those parts of the plate which had been most illuminated, developing the latent image. This process has now been

entirely superseded by the two following pro·

The *calotype* process of Mr. Fox Talbot consists of the following manipulatory details: good letter paper is washed on one side with a solution of the iodide of potassium; it is, when dry, washed with a solution of nitrate of silver, to which a small quantity of acetic acid has been added, and the paper is then washed with clean and pure water. Papers thus prepared will keep without deterioration for some time. To use the paper, a few drops of a solution of nitrate of silver are mixed with about an equal quantity of a saturated solution of gallic acid. This mixture is spread with a glass rod on the prepared side of the paper, which is then placed in the camera. In a few minutes a picture is impressed upon the paper, which is removed from the instrument, and in a dark room again washed over with the mixture, called the *gallo-nitrate of silver*. The [illegible] slowly developes itself, and when it [illegible] ty the [illegible] by plunging it into water; [illegible] l subsequently the picture is fixed, and the [illegible] low colour of the iodide of silver removed [illegible] the use of hot hyposulphite of soda. The [illegible] thus obtained is a *negative* one, i.e. the [illegible] and shadows are reversed; but by taking a copy from this by laying it upon a second sheet of sensitive paper and allowing the light to pass through the negative, a *positive* picture is obtained, in which nature is most faithfully represented with all the delicate gradations of light and shadow. This process has been applied to glass plates in the following manner. Albumen, the white of egg, being strained, is mixed with some iodide of potassium, and floated over the surface of the glass; when dry, the silver solution is applied, and subsequently the gallo-nitrate of silver. Thus prepared, the glass plate is adjusted in the camera, and the image impressed; the remainder of the process is the same as on paper.

The *collodion* process, which is the one now almost universally employed, was invented by Mr. Archer, and consists in impregnating a solution of gun-cotton in ether, with a small quantity of iodide of potassium or cadmium. This solution is termed *iodised collodion*; a film of it is spread upon a plate of glass, and the latter then immersed in a solution of nitrate of silver. The collodion film thus becomes coated with yellow iodide of silver, which is extremely sensitive to light. The film thus prepared requires an exposure of only a few seconds in the camera to produce the *latent image*, which is afterwards developed by pouring over the surface of the plate a weak solution of pyrogallic acid mixed with acetic acid. A solution of protosulphate of iron is also frequently employed for the same purpose. After developing, the excess of iodide of silver still adhering to the plate requires removal, since it would slowly blacken under the influence of light, and thus destroy the picture. This is called *fixing the image*, and is effected by pouring over the plate either a solution of hyposulphite of soda or one of cyanide of potassium. The *negative* picture thus obtained can then be employed for printing a *positive*, as already described. Various modifications of the calotype and collodion processes have been made from time to time, but they differ from the originals only in details which would require too lengthy a description to be inserted here.

Photology (Gr. φῶς, and λόγος). The doctrine of light. [LIGHT.]

Photometer. [PHOTOMETRY.]

Photometry (Gr. φῶς, and μέτρον, *measure*). The process of measuring the intensity of light. Attempts to determine the relative intensities of different lights were made at an early period in the history of experimental science. For the purpose of comparing the light of Sirius with that of the sun, the celebrated Huygens employed a tube having a very small aperture at one end, into which was inserted a minute globular lens, which allowed only the 27664th part of the solar disc to be seen, and this small portion afforded a light which appeared equally bright with Sirius; whence he concluded the distance of Sirius to be 27664 times greater than that of the sun. (Huygenii *Cosmotheoros.*) Celsius appears to have been the first who proposed to measure light directly by means of what he called a *lucimeter*. His method, however, which was an extremely imperfect one, consisted simply in observing the greatest distance from the eye at which small circles painted on paper were distinctly visible in different lights. It was reserved for Bouguer to establish photometry on true principles. Having been induced by Mairan's remarks on the relative proportion of the sun's light at the summer and winter solstice to investigate the subject, he undertook a series of experiments, of which the results were first published in his *Essai d'Optique*, 1729; and afterwards in his *Traité d'Optique sur la Gradation de la Lumière*, which appeared in 1760, two years after his death. In the same year appeared the *Photometria* of Lambert; in which the subject was treated more generally, and with great mathematical elegance. The principle adopted by Bouguer and Lambert is extremely simple. Though the eye cannot judge of the proportional force of different lights, it can distinguish in many cases with great precision when two similar surfaces presented together are equally illuminated, or when the shadows of an opaque object thrown upon them by different lights are equally dark. But, as the rays of light proceed in straight lines, they must spread uniformly, and hence their density will diminish in the duplicate ratio of their distances. From the respective situations, therefore, of the centres of divergency when the contrasted surfaces become equally bright, we may easily compute their relative degrees of illumination.

A simple and elegant application of the principle of Bouguer was made by Dr. Ritchie.

His apparatus consists of a rectangular box, about an inch and a half or two inches square, open at both ends and blackened within, to absorb extraneous light. Within, inclined at angles of 45° to its axis, are placed two rectangular plates of plane looking-glass, cut from one and the same strip, to insure equality of their reflecting powers, and fastened so as to meet at the top, in the middle of a narrow slit about an inch long and an eighth of an inch broad, which is covered with a slip of fine tissue or oiled paper. In comparing, by means of this instrument, the illuminating powers of two different sources of light, they must be placed at such a distance from each other, and from the instrument between them, that the light from every part of each shall fall on the reflector next to it, and be reflected to the corresponding portion of the oiled paper. The instrument is then moved nearer the one or the other, till the two portions of the paper corresponding to the respective mirrors are equally illuminated, of which the eye can judge with considerable certainty.

The modification of this method, which consists in contrasting the shadows of an opaque object formed by different lights, is usually ascribed to Count Rumford, by whom it was proposed in the *Phil. Trans.* vol. lxxxiv. It is generally supposed that the equality of two shadows can be appreciated with more certainty than that of two lights; but, when the lights are of different colours, their estimation by either method admits of little precision.

M. Arago has proposed a method of determining the relative intensities of different lights entirely different in principle from any of the preceding, and probably susceptible of much greater accuracy. It is founded on the properties of polarised light. When two lights are to be compared, the rays from each are polarised by causing them to pass through a plate of tourmaline cut parallel to the axis, or by reflecting them from a plate of glass, on which they fall at the polarising angle. They are then received on a plate of rock crystal, cut perpendicularly to the axis, and observed through a doubly refracting prism. Each light will thus give two images tinged with the complementary colours. The images are then brought into such a position that the red of the one falls over the green of the other. If the two lights are equal in intensity, this superposition will produce a white image; if unequal, the image will be slightly coloured with red or green, according as the one or the other predominates. The apparatus which this method requires is somewhat complicated, and its manipulation must be attended with considerable trouble. (See the notes to the French translation of Sir J. Herschel's *Treatise on Light*, Paris 1833.)

The photometer is most commonly employed for measuring the relative intensities of two artificial lights, or for the comparison of different artificial lights with some standard luminous body, such as a spermaceti candle. For this purpose the most convenient instrument is Bunsen's photometer, which depends for its action upon the combination of transmitted and reflected light. 'The rays from the two lights to be compared are received on the opposite sides of a screen, one part of which is white, and nearly opaque, and the other part translucent. When the rays of a single flame only strike against one side of the screen, those portions through which the light passes seem dark, and the opaque parts bright. But the opposite effect is produced on looking at the back of the screen, for then the opaque part seems dark, and the translucent part is bright. On lighting another flame, on the opposite side of the screen, the dark part is illuminated while the light passes through the other portion, and adds but little to its brightness. Thus the part that is bright on one side is dark on the other, and the reverse. If the light on each side of the screen be equally powerful, the dark part will nearly disappear, for the reflected and transmitted lights combine to illuminate both surfaces equally. When this effect is produced on both sides, by shifting the screen nearer to the feeble flame, the distance from the two is measured, and the relative illuminating power is ascertained by squaring the two distances.' (Clegg *On the Manufacture of Coal-gas.*)

Photophobia (Gr. φῶς, and φόβος, *fear*). An intolerance or dread of light; it is a symptom of internal ophthalmia.

Photozincography. A process for transferring accurate copies of manuscripts or drawings to metal or stone. Paper is washed over with a solution of gum containing bichromate of potash, and allowed to dry in a dark room. It is then placed in contact with the manuscript or design, and exposed to the action of light in a photographic printing-frame. After exposure, the whole surface of the prepared paper is coated with lithographic ink, and then a stream of hot water is sluiced over it. The parts that have been exposed to light have become insoluble in water, and remain unaffected, while the remainder is washed off. The outline thus obtained can then be at once transferred to stone or zinc. [Engraving.]

Phragmites (Gr. from φραγμός, *a hedge*). A genus of grasses closely related to *Arundo*, and often included in it, producing large spreading panicles of flowers at the ends of tall leafy stems. The common Reed, *P. communis*, formerly known as *Arundo Phragmites*, is the largest of our British grasses, growing from six to twelve feet high. It is found on river banks and in wet places, and though of no agricultural value, is of great importance in some situations in binding the earth of river banks with its extensively creeping roots. The stems, or reeds, are used for thatching, and as a foundation for the clay walls of huts and outbuildings in country places. The same species occurs in shallow waters almost all over the globe, from the tropics to the arctic zone.

Phragmocone (Gr. φράγμα, *a partition*, and κῶνος, *a cone*). The essential part of the

complex shell of the Belemnite, consisting of a straight cone divided by numerous transverse partitions perforated by a marginal siphon. From the time of Llwyd conchologists termed this part the *alveolus*, a term which has been recently and properly restricted to the socket of the sheath lodging the *phragmocone*. Belemnites are chiefly distinguished by modifications of the *sheath* or *dart*; but the phragmocone is the constant and true characteristic of this extinct group of Cephalopods, which chiefly flourished from the epoch of the Muschelkalk to that of the Maestricht chalk.

Phrase (Gr. φρασίς, *speech*). In Music, a short portion of a composition, occupying a distinct rhythmical period of one, two, or four bars.

Phraseology (Gr. φρασίς, and λόγος, *science*). This term denotes properly the science or knowledge of style; but it is used in common language to signify the peculiarities of diction of a writer, school, &c.

Phratry (Gr. φρατρία). A subdivision of Athenian citizens, analogous to the Spartan *obé* and Roman *curia*, distinguished by particular rites and ceremonies that bound its members together. Each of the four ancient tribes was divided into three phratries, and each phratry into thirty sections or clans, which bore the name γένος, exactly answering to the Roman *gens*; and this division remained subsequently to and independent of the ten tribes of Cleisthenes. The free Athenians registered their own or their adopted children in the phratries to which they themselves belonged, at the festival of the Apaturia; but what the age of registry was is uncertain.

Phrenic (Gr. φρήν, *the diaphragm*). Relating to the diaphragm.

Phrenitis (Gr. from φρήν). Inflammation of the brain or its membranes. The word, passing through the French form *frénésie*, becomes in English *frenzy*.

Phrenology (Gr. φρήν, *the mind*, and λόγος). This word ought, according to its etymology, to signify mental philosophy; but it has been appropriated by craniologists to the science which professes to be a philosophy of the human mind founded on the physiology of the brain. This science divides our faculties into three classes: the intellectual or perceptive, the sentiments or emotions, and the animal propensities. To the first of these is assigned the anterior portion of the head; the second occupies the middle and upper; while the posterior region and the cerebellum are allowed to the third and most inglorious division.

The subjoined figure shows the three great phrenological divisions of the brain. The line B runs through the centre of ossification of the parietal bone (the organ of Cautiousness, No. 12), and terminates in the centre of ossification of the frontal bone situated at the point where it touches the line A A (the organ of Causality, No. 35). The portion above the line B is named the coronal region, and serves to manifest chiefly the moral sentiments. The line A corresponds to the posterior lateral edge of the super-orbital plate, on which the anterior lobe of the brain rests. The space before the line A A indicates the size of the anterior lobe, the region devoted to the manifestation of the intellectual faculties. If the space before the lower A be long, the organs of the observing faculties are large; and if the space forward from the point where the line B meets the line A A be long, the reflecting organs are large. The space below B and behind A A manifests the propensities common to man with the lower animals. We may remark that in the above figure the coronal region would be said to be large, indicating powerful moral sentiments; the intellectual region about an average, and that of the so-called animal propensities moderate. The organs, it must further be remarked, are double, each faculty having two organs, lying in corresponding situations of the hemispheres of the brain; except in those organs, such as *individuality*, *eventuality*, *benevolence*, &c., represented in the fig. by 22, 30, 13, &c., which occupy the central part of the skull.

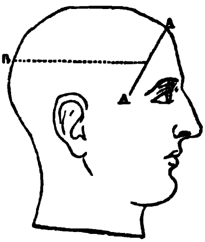


Fig. 1.

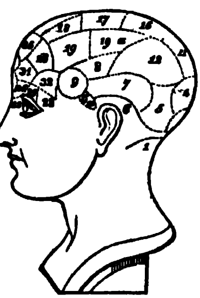


Fig. 2.

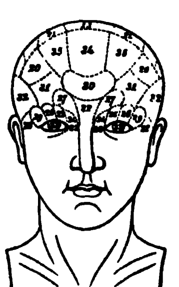


Fig. 3.

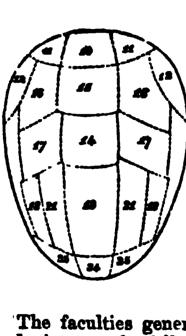
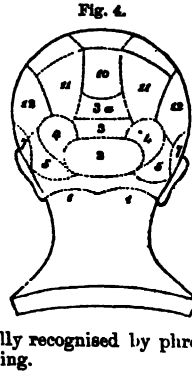


Fig. 4.



The faculties generally recognised by phrenologists are the following.

Order I. Feelings.

Genus I. Propensities—*Common to Man with the Lower Animals.*

The Love of Life.

Appetite for Food.—*Uses*: Nutrition.—*Abuses*: Gluttony and drunkenness. These two organs, it is said, are not fully ascertained, but some facts indicate that they lie in the base of the brain. The first is not marked on the bust, but the second is indicated by 6*a* on fig. 1.

1. Amativeness.—Produces sexual love.

2. Philoprogenitiveness.—*Uses*: Affection for young and tender beings.—*Abuses*: Pampering and spoiling children.

3. Concentrativeness.—*Uses*: It renders permanent emotions and ideas in the mind.—*Abuses*: Morbid dwelling on internal emotions and ideas.

3. *a*. Inhabitiveness.—*Uses*: It produces the desire of permanence in place.—*Abuses*: Aversion to move abroad.

4. Adhesiveness. — *Uses*: Attachment, friendship, and society result from it.—*Abuses*: Clanship for improper objects, attachment to worthless individuals.

5. Combativeness.—*Uses*: Courage to meet danger and overcome difficulties.—*Abuses*: Love of contention and tendency to provoke and assault.

6. Destructiveness.—*Uses*: Desire to destroy noxious objects and to kill for food.—*Abuses*: Cruelty, murder, desire to torment.

7. Secretiveness.—*Uses*: Tendency to restrain within the mind the various emotions and ideas that involuntarily present themselves until the judgment has approved of giving them utterance; it is simply the propensity to conceal, and is an ingredient in prudence.—*Abuses*: Cunning, deceit, duplicity, and lying.

8. Acquisitiveness.—*Uses*: Desire to possess, and to accumulate articles of utility to provide against want.—*Abuses*: Inordinate desire of property; selfishness, avarice, theft.

9. Constructiveness.—*Uses*: Desire to build and construct works of art.—*Abuses*: Construction of engines to injure or destroy, and fabrication of objects to deceive mankind.

Genus II. Sentiments

I. *Sentiments common to Man with the Lower Animals.*

10. Self-esteem.—*Uses*: Self-respect, self-interest, love of independence, personal dignity.—*Abuses*: Pride, disdain, love of dominion.

11. Love of Approbation.—*Uses*: Desire of the esteem of others, love of praise, desire of fame or glory.—*Abuses*: Thirst for praise independently of praiseworthiness.

12. Cautiousness.—*Uses*: It gives origin to the sentiment of fear, and it is an ingredient in prudence.—*Abuses*: Excessive timidity.

13. Benevolence.—*Uses*: Desire of the happiness of others.—*Abuses*: Profusion, injurious indulgence of the appetites and fancies of others, facility of temper.

II. *Sentiments proper to Man.*

14. Veneration.—*Uses*: Tendency to venerate or respect whatever is great and good.—*Abuses*: Senseless respect for unworthy objects consecrated by time or situation.

15. Firmness.—*Uses*: Determination, perseverance, steadiness of purpose. — *Abuses*: Stubbornness, infatuation, tenacity in evil.

16. Conscientiousness. — *Uses*: It gives origin to the sentiment of justice, or respect for the rights of others, openness to conviction, the love of truth.—*Abuses*: Scrupulous adherence to noxious principles when ignorantly embraced.

17. Hope.—*Uses*: Tendency to expect future good; it cherishes faith.—*Abuses*: Credulity with respect to the attainment of what is desired.

18. Wonder.—*Uses*: The desire of novelty. *Abuses*:—Love of the marvellous and occult; belief in prodigies, magic, and other absurdities.

19. Ideality.—*Uses*: Love of the beautiful. —*Abuses*: Extravagance and absurd enthusiasm.

19. *a*. The organ of Sublimity; but not sufficiently ascertained.

20. Wit.—Gives the feeling of the ludicrous, and disposes to mirth.

21. Imitation.—Copies the manners, gestures, and actions of others.

Order II. Intellectual Faculties.

Genus I. External Senses.

Feeling or Touch. Taste. Smell. Hearing. Sight.	*Uses*: To bring man into communication with external objects, and to enable him to enjoy them. —*Abuses*: Excessive indulgence in the pleasures arising from the senses, to the extent of impairing bodily health and debilitating or deteriorating the mind.

Genus II. Knowing Faculties which Perceive the Existence and Qualities of External Objects.

22. Individuality.— Takes cognisance of existence and simple facts.

23. Form.—Renders man observant of form.

24. Size.—Gives the idea of space, and enables him to appreciate dimension and distance.

25. Weight.—Communicates the perception of momentum, weight, and resistance, and aids equilibrium.

26. Colouring.—Gives perception of colours and their harmonies.

Genus III. Knowing Faculties, which Perceive the Relations of External Objects.

27. Locality.—Gives the idea of relative position.

28. Number.—Gives the talent for calculation.

29. Order. — Communicates the love of physical arrangement.

30. Eventuality.—Takes cognisance of occurrences or events.

31. Time.—Gives rise to the perception of duration.

32. Tune.—The sense of Melody and Harmony arises from it.

33. Language.—Gives facility in acquiring a knowledge of arbitrary signs to express thoughts, readiness in the use of them, and the power of inventing and recollecting them.

Genus IV. Reflecting Faculties, which Compare, Judge, and Discriminate.

34. Comparison.—Gives the power of discovering analogies, resemblances, and differences.

35. Causality.—Traces the dependences of phenomena, and the relation to cause and effect.

Such classifications are regarded, by those who do not accept the system of Spurzheim and Gall, as open to the objections of redundancy and deficiency. There is no need, it is said, of two organs for form and size, for combativeness and destructiveness, causality and concentrativeness, each of these two being closely allied, if not identical; while on the other hand, there are no faculties of memory, reasoning, and judgment. To the assertion that each faculty has a power of remembering, reasoning, and judging, it is answered that each of the thirty-five organs is thus shown to have other faculties governing them or attendant upon them; and it is further urged that no account is taken of the propensities to walk, learn, speak, and run, which, with others, exist in men quite as much as the tendency to love, fight, steal, or build. Nor does anatomy, it is argued, sufficiently establish the phrenological hypothesis. The brains of some murderers have been found deficient in destructiveness, while in the skulls of some of the most dexterous thieves acquisitiveness has been small. In other words, although the data obtained by Mr. Deville and others furnish many instances which support the theory, the number of exceptions is too formidable to establish that theory on a firm basis. Still it must be admitted that by forcing the inductive method of enquiry into mental philosophy, phrenology has laid the foundations of a true mental science, and has brought into prominence the fact, ignored by all previous systems, that in the order of nature no consciousness is manifested without a material organ.

The several questions involved in the theory of phrenology are examined in detail in the articles 'Phrenology' and 'Physiology' in the *Encyclopædia Britannica*.

The most hostile enquiry into the pretensions of phrenology to be regarded as a science appeared in 1826, in the *Edinburgh Review*, in an article written by Lord Jeffrey.

Phrixus (Gr. Φρίξος). In Greek Mythology, a son of Athamas and Nephelê, and sister of Hellê, with whom he was borne away from Thessaly on the golden ram, which carried Phrixus to the house of Æêtes, king of Colchis. Hither came the Argonauts [Mysteries] in search of the fleece, which Jason obtained by the aid of Medea.

Phryganidæ. *Case-worm flies.* The family of Trichopterous insects of which the genus *Phryganea* is the type. [Trichopterans.]

Phrygian Marble. [Marble.]

Phrygians. An early Christian sect, so called from Phrygia, the country where they abounded. They regarded Montanus, the founder of the Montanists, as their prophet; and their distinguishing characteristic was the spirit of prophecy to which they laid claim.

Phthah. An Egyptian deity, identified by Herodotus with the Greek Hephæstus.

Phthiriasis (Gr. φθειρίασις, from φθείρ, *a louse*). A disease in which the body is overrun with lice, the Latin *morbus pedicularis*.

Phthisis (Gr.). [Consumption.]

Phthore (Gr. φθορά, *decay*). A name given by some of the French chemists to *fluorine*.

Phycology (Gr. φῦκος, Lat. fucus, *sea-weed*, and λόγος). That part of Botany which relates to the sea-weeds or *Algæ*.

Phycomater (Gr. φῦκος, Lat. fucus, *sea-weed*, and μήτηρ, *mother*). The gelatine in which the sporules of Algaceous plants first vegetate.

Phylactery (Gr. φυλακτήριον, *a protection or preservation*). An amulet or preservative against infection. The phylacteries of the Jews were derived from the injunction contained in Exod. xiii. 9; and consisted of slips of parchment inscribed with verses of the law, enclosed in cases, and worn during prayer on the arm and between the eyes.

Phylæ (Gr. φυλή, *a tribe*). The tribes into which the whole of ancient Attica was divided. Originally there were but four phylæ, which were frequently remodelled, but remained the same in number till soon after the expulsion of the Pisistratidæ, when Cleisthenes raised their number to ten. The precise nature of the change effected on this occasion is not known, but it is probable that the new tribes embraced a large number of citizens that had been excluded from the former. The phylæ were afterwards increased to twelve, by the addition of two in honour of Antigonus and his son Demetrius. The Athenian senate was composed of fifty delegates from each of these tribes.

Phylarch (Gr. φύλαρχος, *ruler of a phylê*). An Athenian officer appointed for each tribe, to superintend the registering of its members and other common duties. The title answers to that of the Roman tribune, but its functions never reached the same importance.

Phyllite (Gr. φύλλον, *a leaf*). A variety of Ottrelite found in clay slate over a large area round Sterling, Gorham, and other places in the United States.

Phyllode or **Phyllodium** (Gr. φύλλον). In Botany, a term applied to the petiole or leaf-stalk in the case of certain leafless plants, in which this part becomes so much developed as to assume the appearance and perform the functions of a leaf. It is commonly met with in the New Holland Acacias.

Phyllonycterans (Gr. φύλλον, and νυκτερίς, *a bat*). The name of a primary division of the order *Cheiroptera*, including the *foliated bats*, or those species which have the ears and nose complicated by grotesque and variously figured membranous foliations, serving the purpose of antennæ, and augmenting the sense of touch in these night-flying and short-sighted species. The tribe is also characterised by having a single finger, the innermost, armed with a hook-shaped claw, and the molar teeth beset with sharp-pointed tubercles adapted for crushing insects.

Phyllophagans (Gr. φύλλον, and φάγω, *I eat*). The name of a tribe of Marsupials, including the Phalangers, Petaurists, and Koala; also of a tribe of beetles, including those which live by suction of the tender parts of vegetables, as the leaves and succulent sprouts.

Phyllopods (Gr. φύλλον, and πούς, *a foot*). The name of a tribe of Crustaceans, comprehending those in which the feet are of a flattened leaf-like form.

Phylloretin. A mineral resin, identical with Könleinite, found in the pine stems in the marshes of Holtegard in Denmark.

Phyllostomes (Gr. φύλλον, and στόμα, *a mouth*). A family of bats, including those in which the nose supports a simple leaf-shaped appendage.

Phyma (Gr. φῦμα, from φύω, *I produce*). A term applied by the ancient physicians to scrofulous tumours. In modern medical language it signifies a tubercle on any external part of the body.

Physa (Gr. φῦσα, *a blast*). A genus of fresh-water snails; so called from the thinness and inflated appearance of the shell. Several species of bubble-shell are found in England; as *Physa fontinalis*, in the Thames; *Physa alba*, in North Wales; *Physa hypnorum*, common in ponds and slow streams.

Physalis (Gr. φυσαλίς, literally *a bubble*). A genus of *Solanaceæ*, of which several species are grown in English gardens. *P. Alkekengi*, the Winter Cherry, has received its name from its scarlet cherry-like fruit enclosed within the enlarged calyx, which renders the plant very ornamental in the beginning of the winter season. The calyx of this plant is frequently macerated so as to separate and preserve the fibrous network of veins by which it is traversed, in the same manner as in preparing skeleton leaves. In Arabia, and even in Germany and Spain, the fruits, which have a slightly acid taste, are eaten for dessert. The fruits of *P. peruviana* are likewise edible, as well as those of *P. pubescens*, the Camaru of Brazil. Some of the species are said to possess medicinal properties. The seeds of *P. somnifera* are stated to be employed to coagulate milk; and, according to Kunth, its leaves have been found with Egyptian mummies.

Physalite (Gr. φυσάω, *to blow*). The name given to a coarse and almost opaque variety of Topaz found at Broddbo and Finbo, in Sweden, which swells when heated.

Physconia (Gr. φυσκών, *a fat paunch*). This term is applied to various enlargements of the abdomen unconnected with dropsy or with accumulations of air, such as morbid states of the liver or of the spleen.

Physeter (Gr. φυσητήρ, *a blow-pipe*). The generic name of the cachalot, or sperm whale.

Physics (Gr. φυσικός, from φύσις, *nature*). The science of nature. In modern language, however, the term has a less general signification than its derivation implies. Nature signifying the assemblage of all the bodies of the universe, the *science* of *nature* comprehends every species of knowledge which regards the external world. But bodies may be studied under three different points of view; they may be examined with relation to their different properties, with relation to their constituent parts, and with relation to their appearances and exterior qualities. These three distinct views give rise to the three great divisions of natural science; namely, *physics*, *chemistry*, and *natural history*. Physics has for its object the study of the properties of bodies and the motions of masses, chemistry studies the motions of their elementary principles, and natural history observes their physiognomy or external appearance.

Physical Forces, Conservation of. Many as are the changes to which the matter forming our earth and atmosphere is subject, its total amount never changes; a law which may be spoken of as 'the conservation of matter.' Force is equally indestructible with matter. A given force may be converted into other forces or produced from other forces; but force as a whole, like matter, can neither be created nor destroyed. This latter subject is usually treated of under the name of the conservation of physical forces.

Physical Forces, Correlation of. The mutual convertibility of the various forces into each other; a doctrine advocated, and to a great extent established, during the last twenty years. Mr. Grove, who was one of the first to propound this doctrine, says that, 'The various affections of matter which constitute the main objects of experimental physics—namely, heat, light, electricity, magnetism, chemical affinity, and motion—are all correlative, or have a reciprocal dependence; that neither, taken abstractedly, can be said to be the essential cause of the others, but that either may produce, or be convertible into, any of the others; thus heat may mediately or immediately produce electricity, electricity may produce heat, and so of the rest, each merging itself as the force it produces becomes developed; and that the same must hold good of other forces, it being an irresis-

tible inference from observed phenomena that a force cannot originate otherwise than by devolution from pre-existing force or forces.' [THERMOTICS.]

Physical Geography. An account of the earth in all its present relations to organic and inorganic nature. The organic subjects belonging to physical geography fall under the headings ZOOLOGY, BOTANY, and ETHNOLOGY. The history of the past if inorganic is GEOLOGY, if organic PALÆONTOLOGY. Of other departments, METEOROLOGY and CLIMATE have reference to the phenomena of the atmosphere, and HYDROLOGY to those of water. The remainder will be considered in a general way in the present article, and details will be found under various headings here designated. Descriptive geography does not come within the scope of the present undertaking; and the astronomical problems, of which there are several that bear on the subject, are considered independently.

Under the term *physical geography*, limited as above, are included accounts of the various phenomena of the land. Thus, the distribution of the land, the form of the land, the division of land into CONTINENTS and ISLANDS, the MOUNTAINS, TABLE-LANDS, PLAINS, and VALLEYS of the larger tracts, and the various details connecting these, are discussed in distinct articles. [LAND, DISTRIBUTION OF; LAND, FORM OF.]

Physical geography regards external nature in its relation to the human race and human interests. It does not in any way consider human history or the results of civilisation, nor does it introduce the consideration of any of those interests that bind together different branches of the human family. Neither does it describe or consider the artificial boundaries of nations, the habits of men, or the difference of races, except when these affect the general grouping of organic beings on the globe.

Physical geography is the history of the earth in its material organisation, as a planet, in so far as it affects and is affected by other bodies of the solar system; as a mass of mixed mineral matter, of which the external crust is varied in its composition, and is subject to certain mechanical and chemical changes, which modify its condition and fitness for life; as the seat of vegetable and animal organisation, infinitely varied, and all adapted to the circumstances in which they are placed.

As a science including many departments, physical geography has risen into great importance within a comparatively brief period, and it is not easy to over-estimate its importance. It is above all the only fit and reasonable introduction to geology, for both the organic and inorganic world are undergoing great change around us, and the history of this change is the clue to those other and greater changes that have brought about the existing condition of things.

Physiocratic System (Gr. φύσις, and κράτος, *power*). A name which has been applied to the theory of political economy supposed to be contained in the works of Quesnay (especially his *Tableau Économique*, 1758), of which the first principle was that the only productive labour is that of those who produce raw material from the soil: consequently, that the most equitable tax was one imposed directly on the net produce of the soil. Turgot and the elder Mirabeau are commonly named as leading sectaries of Quesnay.

Physiognomy (Gr. φύσις, *nature*, and γνώμων, *a judge*). The art of interpreting the indications of the inward disposition supposed to be afforded by the outward appearance, especially the features of the face. (Lavater's *Physiognomy*.)

Physiology (Gr. φύσις, and λόγος, *a discourse*). The science of things generated or alive; but usually regarded as the doctrine of vital phenomena. This science is divided, according to the two great classes of generated beings, into *animal* and *vegetable physiology*. Some philosophers have proposed to change the term for *biology*; but the restricted application of the Greek word *bios* to the life of an individual in other English compound words, as *biography*, would be an objection to this change even if the word *physiology* were less appropriate than it is, or if its use in the sense above defined had not been sanctioned by philosophers of other nations.

The chief object of the physiologist is to ascertain the mode in which each part or organ of a living being reacts when stimulated. When the precise conditions and mode of the reaction of the circulating fluid upon the solids, and reciprocally, are understood, a true and intelligible definition of life may, perhaps, be given.

In animal physiology, the simplest condition under which life can be contemplated is that which it presents in the torpid hybernator.

During this state a dark nutrient fluid, the venous blood [BLOOD], is propelled, by the contractions of a hollow muscle [HEART], along the arteries to every part of the body, whence it is again returned to the heart by the veins. With respect to this chief manifestation of life in the torpid animal it may be asked, What is the cause or condition of the reaction of the fibres of the hollow muscle upon the stimulating fluid? How does each tissue of the body select from the currents flowing through the terminal capillaries the appropriate particles for its growth or reparation, and, in return, add to the blood, either directly or through the medium of lymphatic vessels, its effete particles? These are questions which physiology has yet to resolve: the electric conditions of the parts concerned have not been ascertained. The blood is maintained in a fit state for the preservation of the tissues of the torpid animal by slowly parting with some noxious or useless principles, through the excretion of the kidneys, and of the different mucous and serous surfaces. The reaction of the circulating fluids upon the solids supersedes the ordinary chemical reaction, by which they would be decomposed and destroyed, and thus the torpid

animal is kept alive; but it is the life of the plant or of the ovum. The functions of circulation, nutrition, excretion, are manifested when life is thus reduced, as in the plant, to its simplest condition; and these must, therefore, be its most essential actions. In the torpid animal, the phenomena of irritability and contractility of muscular fibre are superadded, as in the action of the heart: and this is dependent on the connection of the muscular fibre with a nerve. The power of the external decomposing forces is increased by elevation of temperature; and the stimulus of heat produces in the torpid animal, in a manner not understood, a reaction of the mucous surface of the lungs; this reaction influences, through the nerves, the muscles of respiration, and atmospheric air is inspired and brought into contact with the thin membrane over which the pulmonary capillaries are richly spread. The result of this contact is the immediate elimination of the carbon from the blood, which changes its dark for a florid red colour; or converts it from venous to arterial blood.

The blood so changed stimulates in a different and more potent manner the parts over which it is distributed; the heart contracts more vigorously and frequently; the brain and nervous system now receiving more blood, and that of a different kind, begin to react on the application of stimuli to which they were before insensible.

First, self-consciousness; then, sensation of external impressions; lastly, the propagation of a stimulus to the muscular system generally, which produces the reaction of vibratile contraction of its fibre, and by which the animal moves its parts upon each other, or its entire body upon external matter, are successively manifested; and to circulation, nutrition, excretion, and respiration, are now added the functions of sensation and voluntary motion. But with this greatly increased activity of the whole organic machinery, there is a proportional increase of vital decomposition; i.e. of abstraction by the tissues of assimilating particles from the capillary blood, and of addition to the same of effete particles; and those actions demand not only increased activity in the organs which eliminate the waste and noxious particles from the blood, and expel them from the body, but also a means of supplying new blood. This is effected by digestion, chylification, and lacteal absorption.

It is the consciousness of this want that impels the newly roused hybernating animal to seek for its appropriate food: the first use to which the machine is put is to supply itself with the means for its continued activity; and this completes the circle of the functions by which animal life is maintained, as respects the individual being.

It is a law, that the renovation of the parts of a living body should not be uniform: at first the power is in excess, and the body grows; afterwards it is unequal to the waste, and the body shrinks; it is at no period, perhaps, quite perfect; the machinery of renovation thus in time becomes unequal to its office, and the ordinary chemical decompositions and recompositions take the place of those in which life had before essentially consisted.

A given term of life characterises each species of animal; but that the species should continue, it is necessary that the death of the individual be compensated for. This is effected by the power which living beings possess of detaching a portion of themselves; which portion contains in itself potentially all the faculties or functions of life; developes their organs progressively and according to the pattern of the parent from which it was derived; and when arrived at maturity, in like manner generates or separates another portion of itself, with similar powers of developement and growth; then decays and dies. Thus the species of living beings are maintained by the function of generation through a long, but apparently not an indefinite period of time: for the history of the changes of the earth's surface teaches us that the duration of the existence of species, as well as of the individual, is limited, and that many species have become extinct. So far, however, as observation has been able to reach, the death of a species seems to have been rather a violent than a natural one. We have, as yet, had no experience of the extinction of a species by a gradual abrogation of the procreative powers in the individuals of successive generations. Of the mode of introduction of new species, we as yet are ignorant.

The determination of the archetype and homologies of the vertebrate plan of structure led, inductively, to the conclusion that the succession of species was due to the operation of a preordained law or secondary cause. (Owen *On the Nature of Limbs*, 4to. 1849, p. 86.) Hypothetical views and beliefs of its mode of operating have been published by De Maillet, Buffon, Lamarck, the authors of *Vestiges of Creation*, Mr. Wallace, and Mr. Charles Darwin.

The science of physiology is that of the different functions of which life is the manifestation; i.e. of circulation, nutrition, excretion, respiration, sensation, muscular contraction, digestion, absorption, generation; with other subordinate faculties, as the maintenance of equable temperature, the production of vocal sounds, the mental phenomena. To explain these functions, we must first know the instruments by which they are performed; secondly, the matters which they attract, those which they reject, and the nature of that which remains; thirdly, by what forces these matters are transported, attracted, retained, and rejected; and finally, the nature of the stimuli appropriate to each part, and the mode in which such part reacts when stimulated. Physiology has thus many departments, and each department has its anatomical, chemical, dynamical, and what may be termed its purely physiological line of research.

Physiology, Vegetable. [BOTANY.]

Physocalymma (Gr. φυσάω, *to blow*; and κάλυμμα, *a covering*). A genus of *Lythraceæ*, the only species of which, *P. floribundum*, yields the beautifully striped rose-coloured wood called by our cabinet-makers *Tulip-wood*, imported from Brazil. It is the *Bois de rose* of the French, and has of late been largely used for inlaying costly pieces of furniture, as well as for making various articles of small-ware, and for turnery, &c.

Physogrades (a word coined from Gr. φῦσα, and Lat. gradior, *I proceed*). The name of a tribe of Acalephæ, comprehending those which swim by means of air-bladders.

Physostigma (Gr. φυσάω, and στίγμα, *a point*). The Ordeal Bean of Old Calabar, the Eséré of the natives, is the type of a genus of *Leguminosæ* approaching *Canavalia* and *Phaseolus*. This plant, called *P. venenosum*, is a great twining climber, with trifoliate leaves, and purplish bean-like flowers. Its seeds, in which the popular interest in the plant centres, are borne two or three together in dark-brown pods, and are of a blackish-brown colour with a long dark sunk hilum surrounded by a lighter-coloured elevated border. These seeds are extremely poisonous, and are employed by the natives of Old Calabar as an ordeal; persons suspected of witchcraft or other crime being compelled to eat them until they vomit or die—the former being regarded as a proof of innocence, and the latter of guilt. [CALABAR BEAN.]

Phytelephas (Gr. φυτόν, *a plant*; ἐλέφας, *ivory*). A genus of palm-like plants inhabiting South America, and remarkable for producing what is called Vegetable Ivory. Its fruit is of great size, consisting of a collection of six or seven drupes, forming clusters as large as a man's head. Each drupe has from six to nine seeds, which at first contain a clear insipid fluid with which travellers allay their thirst; this afterwards becomes milky and sweet, and by degrees hardens into a substance resembling ivory. Of this hardened albumen, buttons, boxes, and other useful and fancy articles are turned. It is the *Cabeza de Negro* or *Jagua plant*.

Phytocrenaceæ (Phytocrene, one of the genera). A small group of thalamifloral Exogens, by some regarded as a distinct order of the Urtical alliance, but by others referred as a tribe to the *Olacaceæ*. They are all tropical shrubs of no special importance. The stem of *Phytocrene* itself, a plant of climbing habit, is full of limpid watery sap, which is drunk by the natives of Martaban. The name, signifying *plant-fountain*, indicates this quality.

Phytography (Gr. φυτόν, *a plant*, and γράφω, *I describe*). That branch of science which relates to the rules to be observed in describing and naming plants. [BOTANY.]

Phytolaccaceæ (Phytolacca, one of the genera). A small order of monochlamydeous Exogens, referred to the Chenopodal alliance, and consisting of undershrubs or herbs, well represented by *Phytolacca* and *Rivina*, both cultivated in our gardens. *Phytolacca decandra*, the Pocan, or Virginian Poke or Poke-weed, is a branching herbaceous plant whose dark-purple berries, called *Raisin d'Amérique* by the French, contain a purplish-red juice somewhat resembling red ink, and hence it is sometimes called the Red-ink Plant. A tincture made from these berries has acquired a reputation in the United States as a remedy for some forms of chronic rheumatism, and was once a celebrated remedy for cancer. The root is an emetic and cathartic, and the young shoots are extremely acrid, though rendered harmless by boiling; they are eaten in the United States in the same way as asparagus. It is found not only in the United States, but in the Azores, North Africa, and China.

Phytology (Gr. φυτόν, and λόγος). The science of herbs and plants.

Phytophagans (Gr. φυτόν, *a plant*, and φάγω, *I eat*). The name of a tribe of Cetaceous Mammals, synonymous with *Herbivora*. The term is also applied by Lamarck to a section of his order of Trachelipod Molluscs.

Phytotomy (Gr. φυτόν, *a plant*; τέμνω, *I cut*). Vegetable anatomy.

Phytozoa (Gr. φυτόν, *a plant*, and ζῶον, *an animal*). This term is applied by various naturalists to different sections of the subkingdom *Zoophyta* of Cuvier.

Pia Mater (Lat.). A thin vascular membrane covering the convolutions of the brain and the spiral marrow.

Piano (Ital. *soft*). In Music, a direction intimating that the force of the voice or instrument is to be diminished. It is usually expressed simply by the abbreviation P. A double letter PP means *più piano*, or more soft, and PPP *pianissimo*, as soft as possible.

Pianoforte (Ital.). A musical stringed instrument of the keyed species. Its name, compounded of two Italian words, signifying *soft* and *loud*, was probably given to it to distinguish it from the harpsichord and spinet, in which no lightness of touch could lessen the strength of the sound produced, from the quills always striking the strings with equal force; whereas in the pianoforte, the strings are put in vibration by means of small hammers connected by levers with the key or finger board, which hammers quit the string directly it is struck, a damper falling down upon it the moment the finger quits the key. The invention of the pianoforte is ascribed to a German named Schroeder, who lived at the beginning of last century; but it was first introduced into England in 1766 by Zumpe, by whom it was greatly improved. Within the present century this instrument has received many useful and valuable improvements from the hands both of Englishmen and foreigners; so that it may be now fairly regarded as, next to the organ, the noblest and most elegant instrument in the whole compass of musical practice. Many distinguished musicians have devoted themselves to the composition of pieces for this

instrument; and several of the most eminent composers in modern times have made the instrument itself almost their exclusive study.

Piarists (Lat. Patres Scholarum Piarum). Members of a religious order founded at Rome by Casalanza, a Spanish nobleman, early in the seventeenth century. They were bound by a special vow to devote themselves to the purpose of education. They still continue to superintend a great number of schools in Hungary, Poland, Bohemia, &c.

Piassaba or **Piaçaba.** A stout woody fibre, obtained in Bahia from the leaf-stalks of *Attalea funifera* and in Pará from *Leopoldinia Piassaba*. It is used in the manufacture of brooms and brushes.

Piastre. A silver coin used in Spain, Italy, Turkey, South America, the East Indies, &c., varying in value in every country. [MONEY.]

Piauzite. An earthy fusible mineral resin of a brownish-black colour, resembling slaty and lamellar black coal, found at Piauze, near Neustadt in Carniola. It is also met with in Styria, at nearly all the mines in which the carboniferous strata are worked, from Tuffer to Trifail and Sagor.

Piazza (Ital.). In Architecture, a square open space surrounded with buildings. This phrase is improperly used in England to denote a walk under an arcade.

Pibroch (Gael. piobaireachd, *the pipe summons*). Martial music produced by the bagpipe of the Highlanders, but not, as Lord Byron and some others have supposed, the bagpipe itself. Every clan had its own tune, which was scrupulously and sedulously played on all great occasions. The pibroch of Donald Dhu, or the Black, is preserved by Sir Walter Scott (*Songs and Miscellanies*), who wrote a poem on the theme. (*Lady of the Lake*, canto ii. stanza 17; Beattie, *Essay on Laughter and Ludicrous Composition*, ch. iii.)

Pica. In Printing, a type four sizes larger than that used in this work. In all the sizes above canon, types are measured from the number of pica bodies contained in their depths, as *four-line pica, five-line pica*, &c. Leads, or spaces between the lines, are also cast to parts of a pica depth, as *four to pica leads, six to pica*, &c. [PIE; TYPE.]

Picamar. The bitter principle of tar; whence it derives its name (*in pice amarum*).

Picards. The name of a fanatical and immoral sect of Christians who sprang up in Bohemia in the fifteenth century. They derived their name from Picard, a native of Flanders, who styled himself the New Adam, and attempted to revive the absurdities of the Adamites of the second century, in imitating the state of primeval innocence. They were completely annihilated by Zisca, the great general of the Hussites.

Picea (Lat. the *pitch-pine*). A subgenus of *Coniferæ* usually included in ABIES, but by some regarded as a distinct family. The Silver Fir, *Abies picea*, otherwise *Picea pectinata*, is the type, and the principal other species are *P. cephalonica, Pinsapo, Pichta, Nordmanniana, balsamea, grandis, amabilis, nobilis, bracteata, Webbiana, Pindrow, firma, religiosa*, &c. The chief distinguishing feature of this group of Firs is their erect cylindrical thin-scaled cones.

Pichurim Bean. An oblong heavy seed with a musky odour, brought from Brazil, and used medicinally in the cure of colic. It is the produce of *Nectandra Puchury*.

Pici (Lat. picus, *a woodpecker*). The name given by Linnæus to a group of birds corresponding to the *Scansores* and part of the *Passeres* of Cuvier.

Picidæ. *Woodpeckers.* The family of birds of which the genus *Picus* is the type.

Pickeringite. A Magnesia-Alum occurring near the port of Iquique in Peru, in white silky fibres, with a lustre like that of the finest Satin Spar, to which it bears a great resemblance. Named after John Pickering.

Picket (Fr. picquet). In Fortification, a stake used in laying out ground, to mark any required point. Pickets are of various lengths, according to the purpose which they are to serve. One end is sharp and shod with iron, and the other sometimes carries a small flag, for the purpose of rendering it visible at a distance.

The term *picket* is also applied to any small sharp-pointed stake, driven into the ground with the sharp end exposed, to act as an obstacle to an enemy's advance.

PICKET or PIQUET. A small detachment of troops posted on the front and flanks of an army in the field, to guard against surprise and keep off reconnoitring parties of the enemy. [POSTS.]

Picotee. One of the garden varieties of *Dianthus Caryophyllus*. Picotees differ from Carnations in having a lacing or margin of some colour, deeper than the ground, which latter is usually white or yellow, and the border some shade of red or purple; while in Carnations the colouring is laid on in longitudinal stripes, sometimes more than one dark colour occurring in the light ground.

Picræna Wood. The bitter wood sold as Quassia. [PICRASMA.]

Picranalcime. An altered Analcime found in Tuscany, in red crystals.

Picrasma (Gr. πικρασμός, *bitterness*). A genus of small trees belonging to the *Simarubaceæ*. The most important of them is *P. excelsa*, which yields the bitter wood known as Jamaica Quassia, in contradistinction to Surinam Quassia, which is furnished by *Quassia amara*. This bitter-wood tree is very common in the lowlands of Jamaica, where it attains the height of fifty or sixty feet. As commonly met with, it is of a whitish or yellow colour, and has an intensely bitter taste; and hence an infusion or tincture is much used in cases of weak digestion, where a simple bitter is required. It is remarkable that the drug appears to act on animals as a narcotic poison, though such effects have not been witnessed in the human subject; hence the tincture is also used as a fly-poison. The Bitter Cups, extensively sold of late in this country, are, when genuine, made of Quassia-

wood, and water allowed to remain in them for a short time acquires tonic properties. Brewers are said to employ the chips as a substitute for hops.

Picric Acid. *Carbazotic acid.* A yellow crystalline substance formed on boiling indigo or phenylic hydrate with nitric acid. It has great tinctorial power, and is used for dyeing silk and wool of a bright yellow.

Picroglycion (Gr. *πικρός*, *bitter*, and *γλυκύς*, *sweet*). An extractive matter of a bitter and sweet taste, obtained from the stalks of the *Solanum Dulcamara*.

Picrolite (Gr. *πικρός*, and *λίθος*, *a stone*). A name given by some mineralogists to fibrous serpentine. The name has reference to the term *bitter-earth*, sometimes applied to magnesia, which forms many bitter salts, and is one of the components of serpentine.

Weight pharmacolite (Gr. *πικρός*; *φάρμακον*, *medicine*; and *λίθος*, *stone*). A native hydrated arseniate of lime and magnesia, with a large excess of magnesia, from Riechelsdorf in Hesse. Probably it is Pharmacolite with a portion of the lime replaced by magnesia.

Picrophyll or **Picrophyllite** (Gr. *πικρός*, and *φύλλον*, *a leaf*). An altered Augite, occurring in dark greyish-green foliated-fibrous masses, resembling serpentine in appearance, at Sala, in Sweden.

Picrorhiza (Gr. *πικρός*, *bitter*, and *ῥίζα*, *a root*). The only species of this genus is a herb of perennial character, found on the mountains of India, where its bitter roots are used as a febrifuge by the natives, and are sent down to the bazaars of Bengal, where they form one of the many bitter roots sold under the name of Teeta. The species is called *P. Kurroa*, and belongs to the *Scrophulariaceæ*.

Picrosmine (Gr. *πικρός*, and *ὀσμή*, *odour*). A hydrated silicate of magnesia, found in gneiss at the iron mines of Engelsberg, near Presnitz in Bohemia; at Greiner in the Tyrol, and at Waldheim in Saxony. Named from the bitter argillaceous odour which it yields when breathed upon.

Picrothomsonite. A mineral resembling Thomsonite in form, but differing from it in having the soda replaced by magnesia. It occurs in the gabbro rosso of Tuscany.

[illegible] (Gr. *πικρός*, *bitter*, and *τοξικόν*, *arrow-poison*). A poisonous bitter principle which exists in the *Cocculus indicus* of commerce, the berries of *Anamirta cocculus*. consists of carbon, hydrogen, and oxygen.

Pictite. A name sometimes given to Turnerite.

Picts' Wall. One of the barriers erected by the Romans across the northern part Britain to restrain the incursions of the Scots.

Picturesque (equivalent to the Ital. pittoresco, and the Ger. mahlerisch). In the strict sense of the word, all objects which afford fit combinations of form and colour for the imitation of the painter are called *picturesque*. I: literary composition, this term is applied to style which represents objects and events such a manner as to call up vivid impressions of visible reality. Commonly, however, the word is employed by many writers to denote such natural objects as have a somewhat rugged appearance, in contradistinction to those objects which have a *sublime* or *beautiful* character. Thus, in water, that of which the surface is broken, and the motion abrupt and irregular; and, among trees, 'not the smooth young beech, nor the fresh and tender ash, but the rugged oak or knotty wich elm, is picturesque. Among animals, the ass is generally thought to be more picturesque than the horse; and among horses, it is the wild and rough forester, or the worn-out cart horse, to which that title is applied. In our own species, objects merely picturesque are to be found among the wandering tribes of gipsies and beggars; and again in old mills, hovels, and other inanimate objects of that kind.' Such objects, it is argued, are neither beautiful nor sublime; but are, nevertheless, endowed with qualities of their own, which are not only highly suited to the painter and his art, but attractive also to the rest of mankind whose minds have been at all cultivated or improved; and to such objects the term *picturesque* ought to be exclusively applied. (Sir Uvedale Price *On the Picturesque*.)

Piddingtonite. A mineral substance composing nearly the whole of a large meteorite, which fell at Ghalka in the East Indies, November 30, 1860. Named after Piddington, curator of the Museum of Practical Geology at Calcutta.

Pie. The name given to the table used before the Reformation for finding out the service for the day. The origin of the word is doubtful. Some refer it to the Greek *πίναξ*, *a tablet*: others to the litera picata, the large black letter employed at the beginning of each new order in the service. This term still survives in the PICA type. (Hook, *Church Dict.*)

PIE. In Printing, matter broken accidentally, and the letters mixed indiscriminately, instead of being each in its own box in the case.

Pie Poudre Court. In English Law, a court established to decide on the spot disputes arising at fairs or markets. It was styled in Lat. *curia pedis pulverizati*, and derived its name from the itinerant *dusty-footed* dealers (Old Fr. *pied pouldreux*), for whose convenience it was principally instituted. It is now disused.

Pied Droit (Fr.). In Architecture, a pier or square pillar, hidden partly within a wall, for the purpose of receiving the downward thrust of a vault, or of a girder. It is without base or capital, and therein differs from a pilaster.

Piedmontite. Manganesian Epidote from Piedmont.

Pier (A.-Sax. pere, Dutch beere). In Architecture, the solid between the openings of a building, or that from which an arch springs. An abutment pier in a bridge is that next the shore; and, generally, this is made of a greater mass than the intermediate piers, in order to

resist the thrust of the arches which is carried over from the intermediate piers. For the modes of building the piers of bridges, see BRIDGES.

The term *pier* is sometimes employed in Engineering synonymously with that of *mole*, and is used to designate the mass of building erected for the purpose of forming harbours, landing-places, or other similar works.

Pierced. In Heraldry, a term used when a charge is represented as perforated, so as to show the field under it.

Piercer (Fr. perceur). A tool of fine steel, sharpened to pierce the metal or wood work at one end, and made to revolve in a plate at the other; it is set in motion by a piece of catgut attached to the middle of the tool, and connected with a handle moving horizontally.

Pierides. A name of the Muses, who were so called from Pieria, near Mount Olympus. (Hesiod. *Theog.* 53.) Another legend, not noticed in the Hesiodic poems, gives the name to the nine daughters of Pieros, king of Emathia, who, entering into a contest with the nine Muses, were beaten by them and changed into birds. [PARNASSUS.]

Pierrier or **Petrary** (Gr. πέτρος, *a stone*). A term applied at first to an engine for casting stones, afterwards to a small kind of cannon, but now to a mortar used in sieges for firing stones.

Pietists. The name given to certain reformers of the Lutheran church, towards the end of the seventeenth century. The Pietists may be divided into two classes, of which the one proposed to effect merely an amendment of life and manners, and to promote a more evangelical spirit of Gospel truth than was cherished by the reformed churches, which, at the period in question, had degenerated into great coldness and formality. Out of their discussions arose, however, a more violent and fanatical sect, who accompanied their assaults on the doctrine and discipline of the church by the assertion of various mystical extravagances. Arnold, Dippelius, and Petersen were their most distinguished leaders. The same school of theologians gave birth to the enthusiast Jacob Boehm or Behmen. (Mosheim, vol. v. p. 312, trans. 1790.) The term *Pietist* is at present applied, in Germany, much in the same sense of disparagement with which the word Methodist is vulgarly used among ourselves, to those who make a display of strong religious feelings.

Pietra Fungaja. The Italian name for *Polyporus tuberaster*, or Fungus Stone, a kind of fungus, whose spawn has the peculiarity of collecting the surrounding earth into a large ball, which year after year yields a crop of esculent fungi. These balls are articles of commerce, and are transported from place to place, as they generally bear fruit if put in a proper place and well watered.

Piezometer (Gr. πιέζω, *I press*, and μέτρον, *measure*). An instrument for ascertaining the compressibility of liquids.

Pig. [SUS.]

Pig Nut. The tuberous root-stock of *Bunium flexuosum*, so called because pigs are fond of and dig for them. The name is also applied to the tubers of the less common *Carum bulbocastanum*. Both are sometimes called Earth Nuts. Another kind of Pig Nut is the fruit of *Carya porcina*.

Pigeon (Fr.; Ital. piccione). [COLUMBA.]

Pigment (Lat. pigmentum). A term applied by anatomists to the mucous secretion which covers the iris of the eye and gives it its various colours; and to the dark matter which covers the anterior surface of the choroid membrane, and the interior surface of the ciliary processes.

PIGMENT. In Painting, a general term denoting any colour used by artists.

Pigmy. [PYGMY.]

Pignon (Fr.). The edible seeds of various Pine-trees, called *Pinocchio* by the Italians. Those of *Pinus pinea* are eaten in Italy; those of *P. cembra* in the south of Europe; those of *P. sabiniana* in Oregon and California; and those of *P. Gerardiana* in the Himalayas.

Pigotite. A mineral composed of alumina and mudeseous acid forming an incrustation on the sides of certain caves, in the granite cliffs of the Cornish coast. Named after the Rev. M. Pigot.

Pihlite. A green mineral between Talc and Mica, from Fahlun in Sweden.

Pike (so called from the projecting lower jaw, as in French broche, *a spit*, brochet, *a pike*). A well-known species of fresh-water carnivorous fish, common in Europe and North America. Their growth is very rapid; and many instances are on record of their longevity.

PIKE (Fr. pique). In Military affairs, an offensive weapon used in ancient and modern times down to the invention of the bayonet (by which it has been universally superseded), consisting of a shaft of wood of twelve or fourteen feet in length, surmounted with a flat pointed steel, commonly called the spear. It was chiefly used by the infantry.

Pilaster (Ital. pilastro). In Architecture, a square pillar engaged in a wall, usually projecting about one-fifth or one-sixth of its width, but no more. Pilasters are subject to the same rules of proportion as columns.

Pilchard. The *Clupea pilchardus*, a species of herring very common on the shores of the south-west of England, but differing from the common herring in many zoological characters, amongst which the larger size of the abdominal region is the one most prominent to ordinary observers.

The pilchard is taken chiefly off the coasts of Cornwall. The home consumption is very small, most of the fish being exported, when cured, to Italy, Spain, and other countries on the Mediterranean. The general export is about 22,000 hogsheads.

Pile (Lat., Ital., Span., pila). In Artillery, a heap of shot or shells piled up by horizontal courses in a pyramidal or wedge-

like form. The form of the pile is determined by that of the base, which may be a triangle, a square, or a rectangle. In a triangular pile the base is an equilateral triangle, and there is one shot at the vertex. The number in the successive horizontal courses, reckoned from the top downwards, are represented by the triangular numbers 1, 3, 6, 10 . . . . $\frac{1}{2}n(n+1)$, the sum of which is $\frac{1}{6}n(n+1)(n+2)$; the latter, therefore, is the number of shot in a pile of n courses. [FIGURATE NUMBERS.]

PILE. In Heraldry, an ordinary which is represented of a wedge-shape, tapering from the chief downwards towards the point; said to represent the piles on which bridges and other erections are founded.

Pile, Galvanic. [VOLTAIC ELECTRICITY.]

Pile Works. [LACUSTRINE HABITATIONS.]

Piles. A disease originating in the morbid dilatation of the veins of the lower part of the rectum, and upon the verge of the anus, and frequently caused by costiveness and irregularity of alvine evacuation; the contents of the rectum pressing upon the veins, and preventing the return of their blood, so that they become turgid and varicose, often forming bleeding or ulcerated enlargements and tumours. Mild aperients, especially sulphur and castor oil, are necessary in the relief of the early stage of piles; when there is much inflammation, cold and astringent lotions may be used, and the pain is often relieved by fomentation with decoction of poppies. When the tumours are large and flaccid, an ointment of powdered galls, with a little opium and acetate of lead, often affords relief; and, in old relaxed piles, the internal use and local application of copaiba balsam, and even *Ward's paste*, which contains black pepper, do good. In many cases of protrusions of the tumours, they require removal by ligature or by the knife.

PILES (Lat. pila). In Building operations, piles are pieces of timber or iron, driven into the ground or into the bed of a river, for the purpose of supporting the foundations of an edifice or the piers of a bridge. They may be round or square, and when of wood, must be of a quality which does not rot under water, or which is able to resist the attacks of the *Teredo navalis*, and other boring worms or insects. Oak, elm, fir, hacmatac, green heart, &c. are the woods most generally employed for the purpose. The end of the pile that enters the ground is, in these cases, pointed and shod with iron; and the top of it is bound with a strong iron hoop to prevent the piles being split, or their heads beaten up to a kind of pulp, by the violent strokes of the monkey by which they are driven down. Iron piles are now much used, and they are made large enough to allow the foundation to be carried down to the bottom of their penetration; they are described in the following article, which treats of the means of their descent.

The wood piles are known as the *guide* piles, that limit the field of operation; the *close* piles are of whole timber set close together; the *sheeting* piles are of half timber; the *whales* are the horizontal pieces that bind the assemblage together.

Pile-driver. An engine for driving piles. It consists of a large monkey, or block of cast iron which slides between two guide posts. Being drawn up to the top of its course, and then let fall from a considerable height, it comes down upon the head of the pile with a violent blow, proportioned to the weight of the monkey multiplied by the height, diminished, of course, by the friction that the monkey meets with in its descent. It may be worked by men, as in the *ringing engine*; by machinery or by horses, or by men working a crab; or by steam, as in the case of Nasmyth's hammer, or the pile-driving apparatus. Sometimes, when the piles required to be sunk are of great diameter, Dr. Pott's system of pneumatic pressure is applied, or the foundation of the interior is thrown out, and the great weight of the iron ring is trusted to for the further descent of the pile. The reader is referred to a practical paper on Pile Driving read before the British Architects, in 1855, by G. R. Burnell, in which the merits of the various systems are compared with one another.

Pilentum (Lat.). A four-wheeled carriage, with soft cushions, which conveyed the Roman matrons and vestal virgins in sacred processions, and to the Circensian and other games.

Pileorhiza (Gr. πῖλος, *felt-cloth*, and ῥίζα, *a root*). The cap of a root. It is well represented in the ends of the roots of *Nuphar*, where it is seen to form a membranous hood, distinct from the spongiole.

Pileus (Lat.). The felt cap worn by the ancient Greeks and Romans. Among the latter it was the emblem of liberty; hence the phrase *servos ad pileum vocare*, to summon slaves to fight by a promise of freedom.

Pilgrimage (Lat. peregrinus, Ital. peregrino, pellegrino, Fr. pélerin, *a pilgrim*). A journey undertaken for devotional purposes to some spot hallowed by religious associations. The custom of making these pilgrimages has long been recommended and enjoined by the Roman church, and they are frequently imposed by way of penance; the remission of sins, and various spiritual advantages, being promised as the reward of the faithful and pious pilgrim. There exist traces in the history of the early church of such journeys being undertaken occasionally from the natural motives, we may suppose, of curiosity or of a deeper interest. In process of time, the custom of celebrating festivals in honour of martyrs at the place of their sepulture drew larger numbers together from a distance, who, doubtless, soon began to look with some complacency upon their own merits in doing honour to the saints at the expense of fatigue or danger to themselves. But the systematic establishment of pilgrimage as a meritorious work seems to be of much later date. That which was undertaken to the tomb of St.

Martin of Tours is among the earliest canonically enjoined. Such places of devotion became gradually very numerous; of which, however, Jerusalem was held naturally in the highest estimation. The difficulties which presented themselves to the pilgrims who attempted to accomplish this journey, when Palestine had fallen into the hands of the Saracens, were the ate cause of the excitement which armed to the rescue of the Holy Land. The lity of the persons in whose custody these shrines were, and the immorality which ensued from the desultory habits acquired by the pilgrims, called forth the earliest animadversion of the church, at the council of Châlons in the ninth century; but the evil seems to have continued steadily on the increase, until, at the time of the Reformation, we find that a practice originally harmless had degenerated into one of the most crying abuses of the ecclesiastical system. The earliest pilgrimage on record is perhaps that of Helena, the wife of Constantine, to the Holy Land. (Schroeckh's *Kirchen Geschichte*, part v. 8, 19, 23, 25.)

But pilgrimages are not confined to Christian nations. According to a command in the *Koran*, every good Mussulman is enjoined once in his lifetime to repair to Mecca; and many other places, especially in Persia, are endowed with sufficient sanctity to attract multitudes of pilgrims. The Hindus have also their pilgrimages, the most celebrated of which is to the city of Juggernaut, where stands the temple erected in honour of the deity of the same name. Among existing Christian pilgrimages, the most celebrated are those of Trèves, and of Mariazell, in Austria.

Pilidium. The orbicular hemispherical shield or apothecium of a lichen, the outside of which changes to powder, as in *Calycium*.

Pillar. In Architecture. [COLUMN.]

Pillory (Fr. pilori; perhaps from pilier, *a pillar*). A wooden engine on which offenders were formerly exposed to public view, and generally to public insult. It was a common punishment in England, and, by the *statute of the pillory*, 51 Hen. III. c. 6, appointed for forestallers, users of deceitful weights, perjury, forgery, &c. It was finally abolished in 1837 (after having been long disused) by the statute 1 Vict. c. 23. The French punishment of the same description is termed the *carcan*, from the iron collar by which the neck of the criminal is fixed to a post. It is no longer specifically appropriated to particular crimes, but in heavy cases accompanies the sentence of imprisonment or forced labour. [HEALFANG.]

Pillow (A.-Sax. pyle). On Shipboard, a block of timber, in the fore part of the vessel, on which is supported the inner end of the bowsprit.

Pillow Lace. [LACE.]

Pillows. In Machinery, the bearings on which gudgeons and journals rest. They are usually fixed in blocks of cast iron, whence the term *pillow block*, and sometimes, corruptly, *plumer block*.

Pilocereus (Lat. pilus, *a hair*, and cereus, *pliant like wax*). The generic name of the Old-man Cactus, an erect-stemmed plant, with a crown of long flexible white hairs resembling the grey hairs of an old man's head.

Pilose (Lat. pilosus, from pilus, *a hair*). In Zoology, when an animal or part is covered with hair.

Pilot (Dutch pijlloot, properly a person who conducts a ship by the sounding line, from *peilen*, to sound: Wedgwood). A person qualified and appointed by proper authority to conduct ships in and out of particular harbours, or along certain coasts, at a certain fixed rate, depending on the draught of water. The pilot has the charge of the vessel while in *pilot water*, and the captain or master neglects or opposes the pilot's advice on his own responsibility.

The laws relating to pilots and their compulsory employment are consolidated in the Acts 16 & 17 Vict. c. 129 and 17 & 18 Vict. c. 104. (M'Culloch's *Com. Dict.*)

Pilum (Lat.). In the Roman army, the long javelin carried by the Principes and Triarii, as distinguished from the hasta, or pike, borne by the Hastati. [LEGION.]

Pimaric Acid. The purified resin of the *Pinus maritima*: it forms a white crystalline mass. When subjected to dry distillation it yields an oil which has been called *pimerone*.

Pimelic Acid (Gr. πιμελή, *fat*). One of the products of the action of nitric acid on fatty bodies.

Pimelite (Gr. πιμελή). A hydrated silicate of alumina, magnesia, &c.; found at Frankenstein, in Silesia. It is of a greenish colour and translucent; with a greasy feel.

Pimento. The berry of the *Eugenia pimenta*, called Allspice, or Jamaica Pepper.

Pimpernel (Fr. pimprenelle). The common name for the *Anagallis*, one native species of which, *A. arvensis*, also bears the name of Poor-man's Weather-glass, from its property of closing its flowers on the approach of rain.

Pimpinella (a word coined from Lat. bis, and pinna, *a feather*). The genus of Umbellifers to which the Anise belongs. This plant is called *P. Anisum*, and is an annual herb producing warm aromatic seeds.

Pin (Gael. and Dutch pinne, Lat. pinna, *a feather*, as a pointed object: Wedgwood). A small bit of wire, usually brass, with a point at one end and a spherical head at the other. No fewer than fourteen distinct operations are necessary in making this little article; for an account of which see Ure's *Dict. of Arts &c.* There is a good account of this manufacture in Babbage's *Economy of Manufactures*. See also Smith's *Wealth of Nations*, p. 3, where the pin is cited as an admirable instance of the good effects of a division of labour.

PIN. A term of Chinese diplomacy, signifying a petition or address from foreigners to the emperor of China or any of his viceroys or deputies.

In Law, an annuity settled on a married woman, for the purpose of furnishing her with the means of providing for her dress and personal expenses. As it is intended as a personal provision to be expended by the wife de anno in annum in keeping up an appearance suitable to her station, she cannot as a general rule recover more than one year's arrears.

Pinaceæ (Pinus, one of the genera). A name given by Lindley to the CONIFERÆ.

Pinacotheca (Gr. πινακοθήκη, from πίναξ, *a picture*). In Ancient Architecture, an apartment reserved for the exposition of paintings. This term has been applied by the Germans to signify the buildings erected to serve as a national gallery of the works of their best artists, as in Munich.

Pinarii. [POTITII.]

Pinaster (Lat.). The familiar name of *Pinus pinaster*, one of the more useful species of the pine genus.

Pinchbeck. An alloy of copper and zinc; a species of brass much resembling what is now termed *Mosaic gold*. It was brought into notice by a person of the above name.

Pinching (Fr. pincer, *to nip*). In Artillery, the operation of moving a gun or mortar by small heaves of the handspike, without allowing it to turn on its axis.

Pine (Lat. pinus). The common name for the *Pinus* family. [ABIES; PICEA; PINUS.] There are, however, many other plants called Pines, though chiefly of the same coniferous family. Thus Amboyna Pine is *Dammara orientalis*, Chili Pine is *Araucaria imbricata*, and Huon Pine is *Dacrydium Franklinii*, while the Ground Pine is *Ajuga Chamæpitys*, and the Screw Pine is *Pandanus*.

Pine Apple. [ANANAS.]

Pine Wool. The fibre obtained from the leaves of *Pinus sylvestris*, and from which vegetable flannel is manufactured.

Pine-apple Oil. A solution of butyric ether in alcohol has the odour of the pine apple, and is prepared for the use of confectioners as a flavouring material.

Pineal Gland. A small heart-shaped protuberance of the brain, hanging by two peduncles from the beds of the optic nerves immediately over the *corpora quadrigemina*. Some fanciful physiologists have asserted that it is the seat of the soul.

Piney Varnish. The resin of *Vateria indica*.

Pinguite (Lat. pinguis, *fat*). A variety of Chloropal, resembling Bole. It is a hydrated silicate of iron, occurring in dark green masses, which are soft, like new soap, and feel greasy, at Wolkenstein and Geilsdorf in Saxony, and in the Harz.

Pinic Acid (Lat. pinus, *the fir-tree*). The principal resinous constituent of common resin or colophony.

Pinion (Fr. pignon). In Mechanics, a small wheel that plays in the teeth of a larger one, or sometimes into an arbour, or a spindle, having notches or leaves, which are caught successively by the teeth of the wheel, the motion being thereby communicated to the rest of the machinery.

Pinite. An alkaline variety of altered Iolite. It occurs in six-sided or twelve-sided prisms, with their lateral (sometimes with their terminal) edges replaced. It is named after the mine *Pini* in Saxony, where the first specimens were discovered in granite.

Pink. A well-known fragrant garden flower, the *Dianthus plumarius* of botanists. What is called the Clove Pink is *Dianthus caryophyllus*, the source of the Carnation and Picotee, and remarkable for its still more highly aromatic odour. These belong to the order *Caryophyllaceæ*.

Pink, Dutch. In Painting, a colour of a reddish hue.

Pinna (Lat. *a fin* or *feather*). The name of a genus of Ostracean Acephalous Molluscs, commonly called *wing-shells*, remarkable for the size of the byssus, by which they adhere to rocks, and which the natives of Sicily manufacture into gloves, socks, and other articles of sale and ornament.

Pinnace (Ital. pinaccia, dim. of pino, *a ship*). Formerly, a small light vessel with sails and oars; but now generally understood as the second in point of size of the boats belonging to a ship of war.

Pinnacle (Lat. pinnaculum, dim. of pinna). In Architecture, a small square or polygonal pillar, generally, but not necessarily, applied at the angles of a building, terminating upwards pyramidally, and embellished with foliage at the angles of the pyramidal part. It is much used in mediæval architecture, as a termination to buttresses, the tops of gables, &c.; in these positions it is in the form of a spire, with crockets and a finial. The decorated pinnacles have very frequently niches in their faces, and are highly ornamented.

Pinnæ (Lat.). In Botany, the primary divisions or leaflets of a pinnated leaf.

Pinnate (Lat. pinnatus, *feathered*). In Botany, when in a leaf the simple leaflets are arranged on each side a common petiole. It is called *imparipinnate* when there is an odd terminal leaflet, and *paripinnate* when there is an equal number of leaflets on each side, and no odd one. The term *pinnatifid* denotes a leaf divided almost to the axis into lateral segments, something in the way of the side divisions of a feather; while *pinnatipartite* means that the leaf has the lobes separated beyond the middle, and the parenchyma uninterrupted; and *pinnatisect* that it has the lobes divided down to the midrib, and the parenchyma interrupted.

PINNATE. In Zoology, a term applied by Linnæus to the feet of those birds which have the toes bordered by a scalloped membrane, as the coots.

Pinnatipeds (Lat. pinna, *a fin*, and pes, *a foot*). A term applied by Temminck to an order of birds comprehending those which have the digits bordered by membranes.

The name of a section of crabs (Brachyurous Decapod Crustaceans), in which are comprehended those that have the last pair of feet, if not more, terminated by a flattened joint fitted for swimming.

Pinnotheres (Gr. πιννοτήρης). A small parasitic species of crab, which takes up its abode in the shell of the *pinna* and other bivalves.

Pinnules (Lat. pinnula, *a little feather*). The secondary divisions or leaflets of a pinnate leaf.

Pinons. [PIGNON.]

Pinrack. A frame containing sheaves or pulleys, round which ropes can be worked, and pins or cleats to which they can be belayed. Pinracks occur at several places on the upper deck of a ship.

Pint (Fr. pinte, Span. pinta). A measure of capacity, being the eighth part of a gallon. [MEASURES.]

Pintle (akin to Lat. pendeo, *to hang*). On Shipboard, the hook or upper half of each hinge by which the rudder is hung. The pintle projects from the fore-edge of the rudder, as the brace into which it works is fastened to the after-face of the sternpost.

Pinus (Lat.). An extensive genus of *Coniferæ*, confined to the northern hemisphere, and consisting of evergreen trees, with their needle-shaped leaves in clusters, each cluster sheathed at the base by thin chaff-like scales. The genus is of immense economic importance to mankind, more particularly in the constructive arts, its chief products being timber and turpentine.

Pinus sylvestris, the typical Pine of Europe, especially of the northern and central parts, which has a very extensive geographical range reaching from the Mediterranean and Caucasus to Scandinavia, and eastward to Kamtschatka, is known in this country as the Scotch Pine. The tree varies much in size, being at high elevations a stunted shrub, and in more favourable localities a tree fifty or one hundred feet high, furnishing extremely valuable timber, the different varieties of which are known in commerce as Red, Norway, Riga, and Baltic Pine. It also affords a great part of the Wood Tar of Northern Europe, and some Turpentine. *Pinus australis* is the Pitch Pine of the Southern States of North America, where it forms a great portion of what are there termed *Pine barrens*. The turpentine consumed in this country, before the American war, was principally the produce of this species of Pine. It also affords the timber known to builders as Georgia Pitch Pine. *Pinus pinaster*, the Cluster Pine or Pinaster, is indigenous to the European countries bordering on the Mediterranean, and being one of the species that flourish close to the sea, is on that account of vast importance in such districts as the French departments of Landes and Gironde, where, by means of plantations formed of it, enormous tracts of land adjacent to the sea-coast, and formerly occupied by rolling sands, have been reclaimed and rendered useful for agricultural purposes. It is also extremely valuable on account of the great quantity of turpentine derived from it; it has latterly supplied the bulk of that article used in this country.

Pinus pinea, the Stone Pine, is a native of Southern Europe and the Levant. This is one of the species of which the seeds are eaten. They are termed *Pignons* by the French, and *Pinocchio* by the Italians, and are commonly eaten for dessert or made into sweetmeats. Several other species also yield edible seeds: such as *P. Sabiniana*, the seeds of which are collected in immense quantities by the Californian and Oregon Indians as an article of winter food; *P. Gerardiana*, the Neosa Pine of the Himalayas, affording the Neosa or Chilgoza seeds sold as food in the bazaars of Upper India; and *P. Cembra*, the Siberian Cedar, whose seeds are largely consumed by the Russians.

Pioneers (Fr. pionnier, Span. peon, *a footman*). In the Military art, certain soldiers, in all infantry regiments, whose business it is to assist in clearing the road before an army, in sinking mines, and throwing up works and fortifications. Pioneers are provided on a march with shovels, axes, spades, pickaxes, and all other necessary implements.

In our service they carry saw-backed swords instead of muskets, and wear their beards unshaven.

Piotine (Gr. πιότης, *fatness*). [SAPONITE.]

Pip (Fr. pépie). A disease in fowls, in which a white skin or film is formed on the tongue. This skin, if not removed, proves fatal, as it hinders the birds from feeding.

Pipa or **Surinam Toad.** A genus of toads, notable for the convenient arrangement by which the male lays the eggs on the back of the female, where they slowly arrive at maturity. The appearance of the female during the incubation of the eggs exemplifies the maximum of marsupiality.

Pipe (A.-Sax.). A circular or square artificial channel, used for the conveyance of watery fluids, either under pressure or not; or for the passage of aëriform fluids, or of sound. Pipes are made of wood, iron, both cast and wrought; of lead, copper, tin, stone, stoneware, brick, glazed brick, &c.; according to the situation in which they are to be employed, or according to the uses to which they are to be converted. [HYDRAULICS; PNEUMATICS.]

PIPE. A wine measure, usually containing very nearly 105 imperial or 126 wine gallons. Two pipes or 210 imperial gallons make a tun. But, in practice, the size of the pipe varies according to the kind of wine it contains. Thus, a pipe of port contains 138 wine gallons, of sherry 130, of Lisbon and Bucellas 140, of Madeira 110, and of Vidonia 120. The pipe of port, it is to be observed, is seldom accurately 138 gallons, and it is usual to charge what the vessel actually contains.

PIPE. In Music, a tube in which air is caused to vibrate, so as to produce musical sounds. [ORGAN.]

P. A species of clay, abounding in Devonshire, Dorsetshire, and other parts of England, employed in the manufacture of tobacco-pipes and various sorts of earthenware.

Pipefish. The vernacular name of the fishes of the genus *Syngnathus.*

Piper (Lat.; Gr. πέπερι, *pepper*). A genus of shrubby or climbing plants, found in India and the Pacific Islands, and some of them abundantly cultivated for their produce in tropical countries.

P. nigrum yields the Pepper of commerce, a condiment held in high esteem from the earliest times. It is frequently mentioned by Roman writers of the Augustan age, and it is related that in the fifth century Attila demanded, among other things, 3,000 lbs. of pepper as a ransom for the city of Rome. Pepper is cultivated in the East and West Indies, Sumatra, Java, &c., but that which comes from Malabar is held in the highest esteem. The pepper-vine will attain a height of twenty feet or more, but in cultivation it is found more convenient not to allow it to exceed the height of twelve feet. The plants are placed at the base of trees that have rough or prickly bark, in order that they may the more readily attach themselves to the trunk. In three years they produce their spikes of fruits, and continue to do so for some seven or eight years, after which time they become less productive. The fruit, which is red when ripe, is gathered before it is fully matured, and spread on mats in the sun, when it loses its red colour, and becomes black and shrivelled, as we see it in the peppercorns of the shops. This is Black Pepper. White Pepper is the same fruit, freed from its outer skin by maceration and rubbing.

Pepper is imported into this country in enormous quantities, and is used as a condiment. Medicinally, it is employed as an acrid stimulant in cases of weak digestion, and it has also been recommended in cases of ague, to ward off the paroxysm. It is also sometimes employed externally. Pepper on chemical analysis is found to contain a hot acrid resin, and a volatile oil, as well as a tasteless crystalline substance called *piperin,* which has been recommended as a substitute for quinine. This piperin is especially contained in some large coloured cells in the interior of the fruit.

Piperaceæ (Piper, one of the genera). A natural order of shrubby or herbaceous Exogens, inhabiting the hotter parts of the world, and included by modern botanists in the hypogynous division. According to Blume and Richard, they are monocotyledonous; but that they are really dicotyledonous is proved by their medullary rays, articulated leaves, and two-lobed embryo. Their distinguishing characters in the Piperal alliance are in their carpels being solitary, their ovules erect, and their embryo lying in a vitellus. They are related to *Polygonaceæ* and *Urticaceæ*, from which, however, they are distinguished by obvious characters; but much more closely to *Chloranthaceæ* and *Saururaceæ*, the first being distinguished by their suspended ovules and naked embryo, and the second by having several carpels. Common Pepper represents the ordinary property of this order. The Cubebs of the shops is the produce of the *Cubeba officinalis* and *C. canina.* Betel, an acrid stimulating substance, much used for chewing by the Malays, is obtained from *Chavica Betle* and *Siriboa.* Long Pepper consists of the half-ripe flower-heads of *Chavica Roxburghii*, *C. Chaba*, and others.

Piperine (Lat. piper). A white crystallisable substance extracted from black pepper. It is tasteless, and free from pungency, the acrimony of pepper residing in a peculiar fixed oil. It is represented by the formula $C_{68}H_{38}O_{12}N_2$, and is regarded as a feeble alkaloid.

Pipestone. A greyish-blue or black variety of Argillite or clay-slate, found in Northern Oregon, and carved by the Indians into bowls of tobacco pipes.

Pipi Pods. The astringent legumes of *Cæsalpinia Pipai.*

Pipistrelle Bat. The most common bat in England is that which Buffon had termed Pipistrelle, as the most common bat in France is the *Vespertilio murinus* of Linnæus. The Pipistrelle bat is smaller than its French congener.

Pipitzahuac. A chemical product of *Dumerilia Alamani*; it resembles flakes of gold, and is said to be powerfully drastic, to have an odour of Valerian, and to be useful as a dye.

Pippin (Dutch pippeling). A name given to a certain class of dessert apples of which the well-known Ribston Pippin and Golden Pippin are examples. Normandy Pippins are sun-dried apples, pressed, and stored for winter use.

Pippul. The Indian *Ficus religiosa*, or Sacred Fig, remarkable for its heart-shaped leaves with long tail-like points.

Piquet (Fr.). A game at cards played by two persons. It is much practised on the Continent, and deserves to be better known in this country, as it is by far the best two-handed game in existence.

It is played with a pack of thirty-two cards, all below the seven being excluded, which is called a *piquet pack* from this game. The cards rank in the usual whist order—ace, king, queen, knave, ten, nine, eight, seven.

A hundred or a hundred and one points constitute the game, which may last several hands, or be over in one. The score is made partly by combinations of cards held in the hand, and partly by playing.

The two players deal alternately. We will call the non-dealer the elder hand. The cards having been shuffled and cut in the usual way, the dealer gives out twelve cards to each, dealing them in twos, and not singly. He then takes the eight cards that remain (called the *stock*), and places them between the players.

The upper five are supposed to belong to the elder hand, the lower three to the dealer. There are no trum[illegible]

The elder hand has then the privilege of discarding any number of cards not exceeding five (he must discard one at least), and taking a corresponding number from the top of the stock. If he does not take all his five, he may look at those he leaves, concealing them, however, from the other player.

The dealer may then discard, and replace in like manner, taking the cards from the stock in the order in which he finds them. He is not bound to discard any, but he may, if he pleases, take all that remain or any number of them. He may look at any cards of his own portion of the stock he leaves behind; but if he does, the elder hand may demand to see them too, after playing his first card, or naming the suit he intends to play.

The hands being thus made up, the elder hand proceeds to score for the combinations he may hold, in the following manner. There are three things in the hand which may be scored; namely, (1) the point, (2) the sequence, (3) the quatorze.

1. The *point* is counted by the party who has the most cards of any one suit; the elder hand states how many he has; if the dealer has not so many, he says, 'good,' and the elder hand scores one for each card; if the dealer has more, he says 'not good,' and the elder hand, scoring nothing, passes on to the next item. If the dealer happens to have the same number, he says 'equal,' and then the elder hand must count and declare the number of the pips—the ace counting eleven, the court cards ten each, and the others what they are. The highest number of pips makes the cards 'good,' and invalidates those of the other party. If the number of pips is equal, neither scores.

2. The second item is scored by the party who has the best *sequence*, i. e. the greatest number of consecutive cards, not less than three, of the same suit, or if an equal number those of the highest rank; thus, 10, 9, 8, 7, are better than ace, king, queen; but ace, king, queen, are better than king, queen, knave; and so on. A sequence of three cards, no matter what, counts 3; of four cards, 4; beyond this, 10 are added, so that a sequence of five cards counts 15; of six cards, 16; and so on. The elder hand declares his best sequence; if the dealer has a better, he says 'not good;' if only inferior ones, he says 'good.' In the latter case the elder scores, not only for the best sequence, but for every other he holds in his hand; all that the opposite party may hold being invalidated. If the best sequences are equal, neither scores.

3. The third item is called the *quatorze*, from the fact that four aces, four kings, four queens, four knaves, or four tens in one hand, if 'good,' score 14. Three of either kind score 3. In deciding which party is to score, the higher cards are better than the lower, but any four cards take preference of the best three. Thus four tens are better than three aces; but three aces are better than three kings, and so on. The elder hand names his best four or three, to which the dealer says 'good' or 'not good' as the case may be; and, as with the sequence, the one who has the best scores all others he may hold, while those of the opponent are all destroyed.

The point and sequence when scored by either party must be shown to the other; the quatorze need not be.

The items in the elder hand thus being counted, the holder lays down one card, thus beginning the 'play.' The dealer plays to this; but, immediately before doing so, he names and counts all *he* has to score in his hand. The play, the object of which is to gain tricks, follows the ordinary whist rule; the second player being obliged to follow suit, if he can, and the best card winning. If he cannot follow suit, he loses the trick, throwing away any card he pleases.

The scoring of the play is peculiar. The first player of every trick counts one for the card he so plays; but if the second player wins the trick, he also counts one. The party who takes the last trick counts an extra one for it, and if either player wins the *majority* of tricks, he scores an extra *ten*.

This is the ordinary game. There are some additional scores for extraordinary cases; but, before we mention them, it will be well to illustrate the foregoing directions by an example of an imaginary hand, which we recommend learners to play over; it will show that, although the description appears complicated, the practice is very easy.

A and *B* play at piquet. *A* deals, and gives *B* the following cards: 9, 7, of spades; ace, 9, 7, of hearts; 10, 9, 8, of diamonds; ace, 10, 9, 8, of clubs.

A gives himself king, queen, 8, of spades; queen, knave, 10, 8, of hearts; king, queen, of diamonds; queen, 8, 7, of clubs; leaving the remaining cards in the stock in the following order: ace of spades at the top, then king of hearts, 7 of diamonds, knave of diamonds, king of clubs, 10 of spades, knave of spades, and the ace of diamonds at the bottom.

B discards 9 and 7 of spades, and 9 and 7 of hearts, taking in the four upper ones from his stock.

A discards 8 of spades, 7 and 8 of clubs, and takes in king of clubs, 10 and knave of spades, leaving the ace of diamonds unappropriated.

The following dialogue then ensues: *B.* My point is five. *A.* Good. *B.* (shows the diamonds). *B.* My best sequence is knave, 10, 9, 8, 7. *A.* Good. *B.* Also knave, 10, 9, of clubs (shows these and the diamonds). *B.* Then for the quatorze I have 3 aces. *A.* Not good. *B.* Then I score 5 for the point, 15 for the sequence in diamonds, and 3 for that in clubs, making 23. *B.* (plays knave of diamonds) 24. *A.* I score 14 for 4 queens, and 3 for 3 kings, total 17. *A.* (takes the

trick with queen of diamonds) 18. *A.* (plays king of spades) 19. *B.* (takes it with ace) 25. *B.* (plays 10 of diamonds) 26. *A.* (takes it with king) 20. *A.* (plays queen of spades) 21. *B.* (throws away 9 of clubs) 26. *A.* (plays knave of spades) 22. *B.* (answers with 10 of clubs) 26. *A.* (plays 10 of spades) 23. *B.* (answers with knave of clubs) 26. *A.* (plays king of clubs) 24. *B.* (takes it with ace) 27. *B.* (plays ace of hearts) 28. *A.* (8 of hearts) 24. *B.* (king of hearts) 29. *A.* (10 of hearts) 24. *B.* (9 of diamonds) 30. *A.* (knave of hearts) 24. *B.* (8 of diamonds) 31. *A.* (queen of hearts) 24. *B.* (7 of diamonds) 32. *A.* (queen of clubs) 24. *B.* Then I score one for the last card, 33, and 10 for the majority of tricks (he having made seven); this makes me in all 43. *A.* And I score 24. These numbers are then scored towards the game in any convenient way. Some people mark them down with a pencil; some have peculiar counters. We have found the most convenient plan to be a board with holes and pegs like a cribbage-board, only with a hundred and one holes instead of sixty-one.

We have now to notice certain extraordinary chances which affect the scoring in this game; and these are four, the *carte blanche*, the *repique*, the *pique* and the *capote*.

Carte blanche is a hand which, when first dealt, contains neither king, queen, nor knave; this counts 10, taking precedence of every other score.

When either party counts 60 or upwards in hand only, the other counting none, he adds 60 on this account to his score. This is a *repique*.

When the elder hand counts something less than 30 in hand, but can make it up to thirty, by play, before his adversary counts 1, he adds 30 on this account to his score. This is a *pique*. It is obvious that a pique can never be gained by the dealer, as his adversary always counts one for the first card he plays.

If either of the players gain all the tricks, he scores 40 for them, instead of 10 for the majority. This is *capote*.

Pique, repique and capote, are not unfrequent; but the occurrence of carte blanche is exceedingly rare.

We have said that the score, being verbally counted through the playing, is not registered till the hand is over; but, when both parties happen to have arrived near 100, it becomes necessary to register piecemeal in the proper order of priority. This order is, that the carte blanche counts first, then the point, then the sequence, then the quatorze, and lastly the points made by playing as they arise.

The skill required in piquet applies to the rejection of cards from the hand, and to the play, both which offer excellent scope for intelligence and knowledge of the game.

Piracy (Gr. πειρατής, *an adventurer*). In Law, an offence which consists in the commission of those acts of robbery and depredation upon the high seas which, if committed on land, would have amounted to felony there. By stats. 11 & 12 Wm. III. c. 7 and 6 Geo. I. c. 19, piracies committed on the sea or in haven, &c., where the admiral has jurisdiction, may be tried at sea or on land, in his majesty's islands, &c., by commissioners under the great seal appointed for that purpose, who may commit the offenders, and call a court of admiralty for the purpose of the trial. By the same statutes various acts are enumerated as amounting to piracy, and aiders and abettors of pirates are declared accessaries, punishable as principals. By subsequent enactments, acts of trading with pirates, and acts of hostility committed by natural-born subjects against fellow-subjects under colour of a foreign commission, are declared piracy, and by 5 Geo. IV. c. 113 the slave trade is placed on the same footing as piracy. In the realm of England, felonies, robberies, and murders, committed by pirates, are now triable, under the commissions of assize, oyer and terminer, or gaol delivery, as if the offences had been committed on land.

In the Homeric poems, piracy is a recognised and honourable occupation, the inviolability of heralds being apparently the only evidence of any feeling of obligation between one community and another. (Thucyd. i. 5; Grote's *History of Greece*, part i. ch. xx.)

The term *piracy* is also frequently used to signify any infringement on the law of copyright. It is extremely difficult to lay down any general principle on which to decide as to what is and what is not piracy. Generally, it is held, that one writer may borrow the ideas or theories of another; but that he must dress them up and explain them in a different way, and in his own language. This, however, is often done so as merely to evade the law. (See, as to the existing law of piracy, the art. 'Copyright—Books,' in *Com. Dict.*)

Pirene (Gr. Πειρήνη). In Greek Mythology, a daughter of Acheloüs, and nymph of the well Pirene, near Corinth. [Pegasus.]

Pirogue. A kind of canoe, made of the trunk of a tree hollowed out, and used in the southern and eastern seas.

Piscary, Common of. In Law, a liberty of fishing in another man's piece of water.

Pisces (Lat. piscis, *a fish*). The name of the fourth great subdivision of Vertebrate animals, or the class of fishes characterised by a branchial respiration, a bilocular heart, and a covering of scales. The nasal cavities do not communicate with the mouth, but have only external apertures. [Ichthyology.]

Pisces (The Fishes). One of the twelve zodiacal constellations, the twelfth in order from Aries. [Constellation; Zodiac.]

Pisciculture (Lat. piscis, *a fish*, and cultura, *a tending*). The art of breeding, rearing, and cultivating fish. This art was originally practised by the Chinese upon a very large and comprehensive scale. It was subsequently greatly favoured by the Romans, who spent large sums of money upon their fish ponds,

those of Lucullus alone having cost, it is said, a sum equal to more than 30,000*l*. It was carried on through the middle ages by the monks, being a matter of necessity for the observance of their fasts. It was brought almost down to our own time by Jacobi, who wrote a voluminous treatise upon the subject in the *Hanover Magazine*, about a hundred years ago; and its use was really revived in this country by Mr. Shaw of Drumlanrig in 1833. He commenced some experiments in that year to decide the then much vexed question as to whether the little fish found in salmon rivers, and known by the name of the parr, was a young salmon or belonged to a distinct breed of fish. In the elimination of the truth upon this point, Mr. Shaw was obliged to have recourse to the artificial incubation of salmon ova, and since that date his example has been very largely followed. In France the practice was revived by two poor fishermen of Brest, named Gehm and Remy, in 1842, and their labours led to the formation of the magnificent piscicultural establishment near Strasbourg, which was founded and is supported by the French government. Since the first experiments of Shaw, no very great improvement has taken place in the practice. The apparatus employed has been variously modified, but the general plan remains the same; and this, at least for the *Salmonidæ*, is as follows: A tray or a number of trays are prepared, the usual size being from thirty inches to four feet long, and from five or six to eight or ten inches wide. These are either partially filled with gravel, or have grilles composed of glass bars fixed in a wooden frame fitted in them; on these surfaces the ova are thickly strewed, and water is allowed to fall into one end of the tray and to run out at the other, the ova being submerged to the depth of from one to two inches. The ova are thus procured: When the spawning time arrives, the shallows in the streams are carefully watched, and when a pair of fish are observed making their redd or *nidus*, which they do by scooping the gravel into trenches, depositing their eggs therein, and then covering them over with the loose gravel, they are rolled out. The ova of the female is expressed into a pan of clean water. The milt of the male is then expressed over it, the whole is stirred up, is allowed to rest for a few minutes, is then cleansed with fresh water, and borne carefully to its destination. When placed on the gravel or glass bars, it is left to itself to develope, all that is required being a constant supply of cool clean fresh water and perfect rest; in due season the embryo is formed, gathers strength, and finally bursts the egg and springs into life. The *Salmonidæ* are furnished with a large umbilical sac, which is full of glutinous matter, upon which they exist by the process of absorption for some weeks; and when this sac and its contents are finally absorbed, the little animal becomes a perfect fish, and is capable of hunting for its own living. Ova can be safely conveyed very long distances in damp moss under certain piscicultures, and thus we are enabled to transport various kinds of fish from one country to another with comparatively little trouble. The most remarkable instance which has ever been known of this is the conveyance of salmon and trout ova from England to Australia, which was safely effected in the winter and spring of 1864. By packing the boxes containing the ova in ice, a large quantity of the ova arrived in good condition, and some thousands of fry were hatched and reared from it. In this way also the Clyde was stocked with grayling, the Doohullah lakes with salmon-trout and salmon, and the Ballisodare river with salmon. The two latter places are now valuable fisheries, whereas formerly they returned nothing to their proprietors.

The art of pisciculture has now come into general favour, and is very widely practised; very many rivers having on their banks apparatus and rearing establishments belonging to some of their proprietors, which are used to increase the stock of fish contained in the river.

Piscidia (a word coined from Lat. piscis, *a fish*, and cædo, *to kill*). A West Indian Leguminous tree, the pounded leaves and branches of which are used for poisoning fish. It is called *P. Erythrina*.

Piscina (Lat. *a fish pond*). In Ecclesiastical Architecture, a water drain, near the altar on the south side, and usually enriched with ornament. Some churches have double piscinas.

Piscis Australis (The Southern Fish). One of Ptolemy's forty-eight constellations, in the southern hemisphere. The brilliant star Fomalhaut, of the first magnitude, belongs to this constellation.

Piscis Volans (Lat. *flying fish*). A small modern constellation of the southern hemisphere, formed by Bayer. It is situated on the antarctic circle.

Pisé (Fr.). In Architecture, a wall constructed of stiff clay, or other earth, rammed into moulds that give the form of the building, and are removed when the wall is carried up. There are many places where this style of walling is the only one used, as in the chalk districts, the Devonian and the Cumbrian districts, &c.; and there can be no reason for objecting to the use of pisé, provided it be protected from the atmosphere and the humidity of the ground.

Pisidium (Gr. πίσος). A genus of fresh-water Gastropods; so named on account of the resemblance of the shell to a small pea. Many of the species are British; as *Pisidium obtusale*, which may be found in the New River; *P. pusillum*, *P. nitidum*, *P. pulchellum*, &c.

Pisolite (Gr. πίσος, and λίθος, *a stone*). A rock of which the component particles are rounded stones about the size and shape of pease. Pisolite is generally a limestone, differing only from oolite in the greater size of the egg-like particles of which it is made up. Not unfrequently, however, valuable ironstones are found in a pisolitic form in rocks belonging to the oolitic period. This is the

case among the upper beds of the Jurassic series in Switzerland and France. The iron oxide is mixed up with the limestone in so large a proportion as to yield from twenty to thirty per cent. or even more of valuable ore. Other pisolites are known to occur in rocks not belonging to the middle secondary period.

Pissasphaltum (Gr. πισσάσφαλτος). Mineral pitch; a soft bitumen, of the consistence of tar, and intermediate between petroleum and asphalt. The ancient Greeks gave the name to the liquid as well as to the solid bitumen.

Pissophane (Gr. πίσσα, *pitch*, and φαίνομαι, *to seem*). A hydrated sulphate of alumina and peroxide of iron, found in transparent, stalactitic or amorphous masses, of an olive-green or liver-brown colour, in the decomposing alum-slate of Garnsdorf, near Saalfeld, and of Reichenbach, in Saxony. It resembles pitch in colour and fracture.

Pistachio Nuts (Fr. pistaches, Ital. pistacchi, Lat. pistaciae). The fruit of the *Pistacia vera*, which grows naturally in Arabia, Persia, and Syria; also in Sicily, whence the nuts are annually brought to this country. They are oblong and pointed, about the size and shape of a filbert, including a kernel of a pale greenish colour, covered with a yellowish or reddish skin. They have a pleasant, sweetish, or unctuous taste, resembling that of sweet almonds; their principal difference from the sweet almond consisting in their having a greater degree of sweetness, accompanied with a light grateful flavour, and in being more oily. Pistachio nuts imported from the East are superior to those raised in Europe.

[illegible] (Lat.; Arab. fonstaq). The plants of this genus of *Anacardiaceæ* are called Turpentine-trees, and are mostly of small stature, and furnished with pinnate leaves. The most important species are the Mastic-tree, *P. lentiscus*; the Cyprus Turpentine-tree, *P. terebinthus*; and the Pistacia-tree, *P. vera*, which yields the PISTACHIO NUTS.

P. lentiscus, the Mastic-tree, a native of Southern Europe, Northern Africa, and Western Asia, is a small tree growing to the height of fifteen or twenty feet. The Mastic or Mastich is the resin of the tree, and is obtained by making transverse incisions in the bark, from which it exudes in drops, and hardens into small semitransparent tears. It is principally produced in the island of Scio and in Asiatic Turkey, and is consumed in large quantities by the Turks, who chew it to sweeten the breath and strengthen the gums; hence its name, from *masticare*, to chew. In this country it is used for varnishing pictures, and by dentists for stopping teeth.

P. terebinthus, the Chio or Cyprus Turpentine tree, or Terebinth, is likewise found in Southern Europe, Northern Africa, and Asia. The turpentine flows from incisions in the trunk, and soon becomes thick and tenacious, and ultimately hardens. It is collected in the islands of the Greek Archipelagos, but seldom comes to this country. Curious horn-shaped galls, caused by the punctures of insects, are found in large numbers upon the Terebinth-tree, and are collected for dyeing and tanning purposes—one of the varieties of Morocco leather being tanned with them.

Pistacite or **Pistazite.** A green silicate of alumina, lime, and iron. It is a variety of iron-and-lime Epidote in which much of the lime is replaced by protoxide of iron, and a large proportion of the alumina by peroxide of iron. It occurs, embedded in many crystalline rocks, in Shetland in Syenite, Rona in Quartz, Mull and Skye in Trap-rock. The finest crystals are from Arendal in Norway, and from several parts of the Alps. The name refers to the *pistachio*-green colour of the mineral.

Pistiaceæ (Pistia, one of the genera). An unimportant order of aquatic Monocotyledons, represented in our own country by the *Lemna* or Duckweed, and in the tropics by *Pistia*, from which it derives its name, and which is called in the West Indies, Water Lettuce.

Pistil (Lat. pistillum, *a pestle*). In Botany, the organ which occupies the centre of a flower, within the stamens and disc (if the latter be present). It is distinguished into three parts: an upper or stigma, a lower or ovarium, and a central part or style. It is the female organ of the flower, and contains the ovules or young seeds within the ovary.

Pistol (Fr. pistole, Venetian piston, *a kind of arquebuss*). A short fire-arm with a curved stock for use with one hand. The cavalry in the British service are armed with pistols, length 13¾ inches, length of barrel 8 inches, weight 40 ounces, calibre ·577 inches, five progressive grooves having a pitch of one turn in four feet.

Pistole. A gold coin common in many parts of Germany, equivalent to about 8*s.* 6*d.* sterling.

Pistomesite (Gr. πιστός, *trusty*, and μέσος, *middle*, because it is a mean between Magnesite and Sparry Iron-ore). A variety of Breunnerite, composed of one atom of each of the carbonates of magnesia and iron. It is found at Thurnberg, near Flachau, in Salzburg.

Piston (Fr.; Ital. pestone). In Machinery, this term is applied to a short cylinder of wood, or of metal, which fits exactly into the cavity of a pump, barrel, or steam engine cylinder, and works up and down this alternately. Two sorts of pistons are used in pumps; one hollow with a valve, used in the suction pump; and the other solid, which is generally employed in the forcing pump. In steam cylinders, the piston is usually made so as to be *self-packing*, so that the cylinder should always be occupied by the piston: this is effected by the introduction of springs that press a movable ring against the sides of the cylinder. [STEAM ENGINE; PUMP.]

Pisum (Gr. πίσον, *pease*. 'Pea in the singular is a modern corruption on the supposition that the *se* of *pease* belonged to the plural form: the old plural was peason.' Wedgwood). The genus to which belongs

the cultivated Pea of the kitchen garden; it is very closely allied to *Lathyrus*, which includes the Sweet Pea of the flower garden.

The Common Pea, *P. sativum*, is a hardy annual of great antiquity, and one of the most valuable of cultivated legumes. Its native country is unknown, but it is generally understood to be the South of Europe. The supposition that it was introduced into this country, by way of Holland or France, about the time of Henry VIII. is erroneous. Entries of peas are very common during the reigns of the first three Edwards.

The use of peas is familiar to everyone. In their dried state they are split and used for soups, or ground into meal for puddings, in either case forming an agreeable and nourishing food, containing upwards of one-seventh more of nourishing matter than is found in the same weight of wheaten bread. But it is in a green state that peas are most valued for culinary purposes, and more particularly when they are quite small and young. In Queen Elizabeth's time (about 1570), we are told, they were occasionally brought from Holland, and considered 'a dainty dish for ladies—they came so far and cost so dear.' For many years their culture does not appear to have been much attended to, but after the Restoration of Charles II. in 1660 the taste for green peas became fashionable, and has continued to be so up to the present time. To have peas in the highest perfection, they should not be allowed to get too old or too large. When the pods become full and hard, the peas are then more suitable for soups than as a vegetable dish.

Besides the edible-seeded peas, there are some called *Sugar-peas*, remarkable as having the pods destitute of the inner film peculiar to the pods of the other kinds, so that they are more fleshy and crisp, and admit of being cut and dressed in the same manner as French-beans.

Pit (akin to Lat. fodio, *I dig*). In Horticulture, a term applied to glass-covered structures smaller than greenhouses, in which very generally there is not space for the cultivator to enter, all the cultural operations being performed from the outside; very frequently also (and probably hence the name) they are excavated below the natural surface, either to secure protection against frost, or to gain height for tall-growing plants. They may have brick, wood, or turf sides with a wood plate and glass sashes at top, the glass being nearly level with the ground, or more or less raised; but, unlike a garden frame, which they resemble, they are fixed, not movable from place to place. They are most commonly what are called *cold pits*, which means that they are not artificially heated, and are used for the protection in winter of hardy and half-hardy plants, and in summer for the culture of plants requiring a close moist atmosphere. In addition, any small low glass erection heated or otherwise may be called a *pit*, and this may either be span-roofed, or what is called a lean-to, with only a single slope. Of such a character are what are called *cucumber pits*, propagating pits, &c. The terms *pit* and *frame* include both structures like the foregoing, and movable garden frames, which latter are of wood with glass sashes.

Pit Saw. A toothed saw used for the sawing of wood, in which two men are employed, the one above the log, the other below it. It is not necessary that the log should be placed over a pit, but it is generally so placed; hence the name.

Pit-coal. [COAL; GEOLOGY.]

Pita. A name given to *Agave americana* and the allied species. Pita-fibre and Pita-thread are names for the fibres obtained from the leaves of the larger Agaves. It is also called Aloe-fibre.

Pitch (Ger. pech, Lat. pix, Gr. πίσσα). The same as ASPHALT and BITUMEN.

PITCH. The residuum which remains after boiling tar in an open iron pot, or in a still, till the volatile matter be driven off. It is chiefly used in shipbuilding.

PITCH. In Music, the degree of acuteness or graveness of a note. [MUSIC.]

PITCH (akin to the verb, to *pick*). In Wheel-work, this word signifies the distance between the centres of two contiguous teeth. *Pitch line* is the circle, concentric with the circumference, which passes through all the centres of the teeth.

Pitch Coal. A name given to Jet, from its pitch-like appearance.

Pitch Opal. An inferior kind of Common Opal.

Pitch of a Roof. In Architecture, the inclination of the sloping sides of a roof to the horizon. It is usually designated by the ratio of its height to the space covered.

Pitch of a Screw. The interval between the point of starting and arrival of a complete revolution of a screw, and consequently of the thread of a screw, which is traversed by the screw, or its thread, when it has completed an entire revolution. The pitch is therefore independent of the diameter of a screw.

Pitchblende or **Pitch-ore.** An oxide of Uranium, composed of 84·78 per cent. of Uranium, and ·15·22 oxygen. It is opaque, of a greyish-greenish or brownish-black colour, and very brittle. It occurs amorphous, generally massive and disseminated, also botryoidal and reniform, with a columnar or curved lamellar structure. Its principal localities are Norway, Saxony, Bohemia, Hungary, and Adrianople in Turkey. In Cornwall it is found at St. Austell Consols, Tin Croft, and some other mines. The chief use to which this ore is applied is for the preparation of oxide of Uranium, which is employed, under the name of *Uranium Yellow*, for imparting to glass the pale opalescent sea-green colour which is much admired in Turkey. It is also used in porcelain painting, and in the new photographic process, the Wothlytype.

Pitcher Plant. The *Nepenthes*, a rare and curious genus of tropical climbing plants in which the extremity of the leaf is hollowed

out in the form of a pitcher and furnished with a lid or cover. The Australian Pitcher Plant is of different habit, and is called *Cephalotus follicularis*.

Pitching a Tent. Raising or erecting a tent. A ditch should be dug round a tent, if it is likely to rain; and the tent ropes should be slackened off when wet, or they will tear up the pegs. If the ground is sandy, so that tent pegs will not hold, bushes, &c. may be buried two or three feet deep, and the tent corners tied to them.

Pitchstone. A form of Obsidian or Volcanic Glass, the lustre of which resembles that of pitch or resin, rather than glass. It is of various colours, and is less glassy than Obsidian, from having cooled more slowly.

Pitchy Iron-ore. A name given to Triplite and also to Pitticite, from its resemblance to pitch.

Pith (A.-Sax. pitha). In Botany, the cylindrical or angular column of cellular tissue, arising at the neck of the stem of a Dicotyledonous plant, and terminating at the leaf-buds, with all of which, whether they are lateral or terminal, it is in direct communication. It forms the centre of a stem, and is covered over by the wood. Its use is to act as a reservoir of nutritious matter for the young leaves when first developing.

Pithecus (Gr. πίθηκος, *an ape*). The subgeneric name of the orang-utan; *Pithecus satyrus*, Geoff., and *P. morio*, Owen.

Pito. A sort of beer, made from the fermented seeds of *Zea Mays*.

Pitot's Tube. In Hydraulics, an apparatus, so called from the name of its inventor, for measuring the velocity of a stream, or of a body moved through stagnant water. A tube open at both ends is bent into two unequal branches at right angles to each other. It is then placed in the stream, the longer branch in a vertical position, and the shorter turned round so that the water enters directly into the orifice, which should be somewhat contracted. When thus placed, the water enters the tube with the velocity of the stream, and the pressure causes it to rise in the upright branch of the tube to the height from which it must have fallen in order to acquire this velocity. The height to which the water rises in the tube is measured by placing a graduated rod in the tube, of such specific gravity, as to float on the water; or if the tube is of glass, the height may be measured externally. The corresponding velocity is obtained from the formula

$$v = \sqrt{(2gh)};$$

where v denotes the velocity, g the accelerating force of gravity, and h the height to which water rises in the tube, all expressed in units of the same denomination. The result is tolerably accurate, except when the velocity is small; but the effect is somewhat diminished by the friction on the tube.

Pitt's Mark. In Printing, a technical term for the printer's name and residence, compelled to be affixed to printed books by Mr Pitt's Act, 39 Geo. III. c. 79.

Pittacal (Gr. πίττα, *pitch*, and κάλλος, *beauty*). A blue substance, obtained by the action of a solution of baryta upon the heavy oil of tar.

Pittenite or **Pittenerz.** A variety of Pitchblende, which occurs in pitch-black amorphous masses at Joachimstahl in Bohemia.

Pitticite or **Pittizite** (Gr. πίσσα or πίττα, *pitch*, from its pitch-like appearance). An arsenio-sulphate of peroxide of iron, found in small reniform and stalactitic masses near Freiberg and Schnerberg in Saxony, also in Upper Silesia, Bohemia, Brittany, Chili, &c. The name Pitticite is applied by Beudant to ochreous sulphate of iron.

Pittosporaceæ (Pittosporum, one of the genera). An order of polypetalous Exogens of the hypogynous division, and referred by Lindley to the Berberal alliance. They are chiefly found in Australia; and are distinguished by their regular symmetrical flowers, their imbricated petals and alternating stamens, their axile and parietal placentæ, and their ascending or horizontal ovules. *Pittosporum Sollya* and *Billardiera* are examples.

Pituitary Gland (Lat. pituita, *phlegm*). A gland situated within the cranium, between a fold of the *dura mater*, in the *sella turcica* of the sphenoid bone.

Pituitary Membrane. The mucous membrane of the nose.

Pityriasis (Gr. πιτυρίασις, from πίτυρα, *bran*). A cutaneous disease consisting of irregular scaly patches, unattended by inflammation. When it affects infants, it is called *dandriff*. A similar exfoliation of the cuticle in reddish patches is not uncommon in adults. Soap and water, and mild cooling lotions, or very weak nitro-muriatic lotion, are the best applications.

Più (Ital.). In Music, a word frequently prefixed to another to increase the strength of its meaning; as *più allegro*, a little quicker.

Pivot (Fr.; Ital. pivolo). In Mechanics, the extremity of the axle about which a body revolves.

PIVOT. In Military language, that officer or soldier upon whom a wheel is made. The rule in the English service is, 'When right is in front, left is the pivot flank, and vice versâ.' Strict attention to this law of pivots adds much to the difficulties of drill, and it is to be hoped that for cavalry, at all events, it will soon be abandoned.

Placard (Fr. akin to Ger. flach, and Gr. πλάξ, *a flat surface*). A writing affixed to a wall, post, &c. in a public place, is commonly so called; and as this was in ancient times the common mode of publishing proclamations and edicts, and also of giving notoriety to libels and seditious advertisements, the word is not uncommonly used in early modern writers in both these senses.

Place Bricks. Bricks underburnt, but still retaining their shape and coherence, whether

obtained by kiln or clamp burning. The place bricks are, in fact, bricks of the third quality; the first being the *paviors*, or bricks selected on account of their hardness for the purpose of being used as paving bricks; then the *stocks*, or the average quality of the manufacture; the *place bricks*; the *shoughs*, or the broken and disfigured bricks; and the *clinkers*, or the hard-burnt and disfigured masses of clay that are run together from the effects of the fire.

Place of a Heavenly Body. That point in the heavens which the body seems to occupy (after allowing for the effects of refraction), when viewed from the surface of the earth. It is also called its *apparent* place. The point in the heavens where the body would be seen if it could be viewed from the centre of the earth, is called its *true* place.

Placenta (Lat.; Gr. πλακοῦς, πλακοῦντος, *a cake*). The after-birth. In the human subject it is a single subcircular, flattened, and lobulated organ, composed of the capillary extremities of the fœtal hypogastric arteries and umbilical vein, and of a fine cellular structure, which receives the maternal blood from the tortuous uterine or decidual arteries.

The placenta forms a single lobe in the New World monkeys, the bats, the Insectivora, and the Rodentia. It surrounds the fœtus like a broad hoop in the Carnivora. It is bilobed in the Old World monkeys; and subdivided into many separate lobes, called Cotyledons, in the true Ruminantia. The placenta is replaced by a diffused vascular villosity of the chorion in the *Camelidæ*, the ordinary Pachyderms, and the Cetacea. The placenta is absent and the chorion ceases to be vascular in the Marsupialia.

PLACENTA. In Botany, a copious developement of cellular tissue, formed at some point of the inside of a carpel, and out of which the ovules or young seeds arise.

Placentalia. The name of that primary division of the class Mammalia which includes the orders that have either a placenta or a vascular chorion, by which the fœtus is attached to the parietes of the uterus.

Placentaries. In Botany, the pistillary cords, or attachments of the ovules.

Placentation (Lat. placenta). In Botany, the manner in which the placenta is developed or placed, or in which the ovules are borne.

Places of Arms. In Fortification, enlargements in the covered way, at the re-entering and salient angles of the counterscarp; hence the term *re-entering places of arms* and *salient places of arms*.

Placita (Lat.). In the Middle Ages, public courts or assemblies, in which the sovereign presided when a consultation was held upon the affairs of the state. They were termed *Generalia Placita*, because 'generalitas universorum majorum tam clericorum quam laicorum ibidem conveniebat.' The same custom appears to have existed in France, with a slight modification. According to the *Black Book* in the Exchequer, lib. ii. lit. 13, this term was also applied to penalties or fines.

Placodus (Gr. πλάξ, *a flat surface*, and ὀδούς, *tooth*). A genus of muschelkalk Sauropterygian reptiles which was considered for many years by Agassiz and Münster to be a genus of fishes. The teeth were especially adapted for crushing hard shells of *Mollusca*. In all the species there are two rows of crushing teeth in the upper jaw and only one in the lower, on each side the mouth, the lower row playing upon both upper rows, with its strongest (middle) line of force directed against their interspaces. Thus the crushing force is best economised and directed for mastication.

Placoganoid. A suborder of GANOID fishes in which the endoskeleton is cartilaginous or notochordal; head and more or less of the trunk protected by large ganoid, often reticulated, and suturally united plates; the tail is heterocercal. It is divided into two families, the *Ostracostei* and the *Sturionidæ*.

Placoid (Gr. πλάξ). An order of fishes in the system of Professor Agassiz, in which the scales have each a spine projecting from them; the scales of placoid fishes, as e.g. the shark and dogfish, exhibit when tesselated together the structure which is used commercially under the name of *shagreen*.

Plagal Melodies (πλάγιος, *oblique*). In Music, such melodies as have their principal notes lying between the fifth of the key and its octave or twelfth.

Plagianthus (Gr. πλάγιος, *oblique*, and ἄνθος, *a flower*). The inner bark of the young shoots of *P. betulinus* yields a tough fibre sometimes called New Zealand Cotton; and another species, *P. sidioides*, is one of several plants called Currajong, which yield a tough fibrous bark, capable of being converted into good cordage and twine. It is a genus of *Sterculiaceæ*.

Plagiarism (from the Latin legal term plagium, which signified the offence of stealing a slave, or kidnapping a free person into slavery). A plagiary, in the modern sense of the word, is one who borrows without acknowledgement, in literary composition, the thoughts or words of another; and the theft itself is styled *plagiarism*.

Plagiaulax (Gr. πλάγιος, *oblique*, and αὖλαξ, *a furrow*). A genus of fossil carnivorous marsupial Mammalia, allied to *Thylacoleo*. Its remains have been found in upper oolitic strata at Purbeck, with the carnassial genus *Triconodon*, and the entomophagous genus *Spalacotherium*.

Plagionite (Gr. πλάγιος, *oblique*; from the form of the crystals). A sulphide of lead and antimony found in thick, tabular, four-sided prisms, and also massive and granular, of a dark lead-grey colour, at Wolfsberg in the Harz, on Quartz.

Plagiostomes (Gr. πλάγιος, and στόμα, *a mouth*). A tribe of Cartilaginous fishes, comprehending all those which have the mouth situated transversely beneath the snout. Also the name of a genus of Univalve Molluscs.

Plague (Gr. πληγή, Lat. plaga, *a blow*). When any endemic disease, of novel or pecu-

liar character, is communicated by infection, i.e. by and with an altered condition of the atmosphere consequent upon the dispersion of the existing causes of the disease through the air, and is marked by excessive mortality, especially at the commencement of the malady, the word *plague* is used to express such phenomena. After a plague has once visited mankind, it seldom dies out entirely, but is excited, though under less destructive forms, by neglect of sanitary precautions or by any causes which depress the vital energies.

All plagues have been derived from Asia. The first calamity of this kind of which we have a distinct description is that of Athens, B.C. 430, the symptoms of which are given at length by Thucydides (ii. 47–54). This great historian was himself affected by it, and saw it in many other persons. Careful as his account is, it is not quite clear whether it was small-pox or scarlet fever. It seems, indeed, to have combined the symptoms of both these diseases; of the former, by the exanthematous character of the eruption, and the frequent destruction of the extremities; of the latter, from the lividity of the skin (for a Greek's cuticle would, under the influence of scarlet fever, put on a very different colour from that of a light-complexioned person), and from the excessive redness of the mouth and fauces.

Similarly, the black death of the year 1348 began in the extreme east of China fifteen years before it visited Europe. It travelled, as plagues commonly travel, very slowly, and was accompanied by marked atmospheric changes. Its peculiarity lay in its attacking (unless the person died almost suddenly) the course of the absorbents, and in inducing suppuration of the glands; in exhibiting, in short, all the symptoms of blood poisoning. It still exists, under the name of the Levant or Egyptian plague, though in a very mitigated form.

Later than this plague came the sweating sickness, the ravages of which disease were limited to the last half of the fifteenth and the first half of the sixteenth century.

In the middle of the eighteenth century, the same Eastern source supplied Europe with a new disease, to which the name *influenza* was given. It was characterised by the symptoms of severe bronchial affection, and by great physical depression. It has been suggested that influenza is due to the diffusion of minute particles of selenium through the atmosphere. This substance is one of the products of volcanic eruptions, and when disseminated in the air, by any experiment or from any special source, produces those characteristic features of bronchial irritation which belong to influenza.

Lastly, CHOLERA sprang up in a part of Central India which had been desolated by earthquakes. The symptoms of this disease are too well known. It seems to attack the mucous membrane of the bowels, just as influenza does that of the bronchial tubes. It is possible that hereafter the analysis of the spectrum will enable physiologists to determine with precision the motive causes of this disease, as well as of others, by an examination of infected air.

Of these calamities, two produced, at their first incidence, according to the testimony of eye-witnesses, grave social consequences. Thucydides tells us that the plague of Athens demoralised the people, partly by inducing an impression of the utter uncertainty of life, partly by supplying the means of unbounded enjoyment to those who, previously suffering from penury, succeeded suddenly to the estates of rich relatives, whole families having perished by the ravages of the pestilence, and having left their estates to distant heirs. Perhaps Thucydides is somewhat querulous; he gives, indeed, another reason for the prevailing depravity of morals, the great length and increasing ferocity of the Pelóponnesian war, in which a struggle that began with a contest for political supremacy became gradually a war of races, and ultimately left Greece an easy prey to a semibarbarous chieftain on her frontier. We make no doubt that the plague had a bad moral effect; but other causes concurred to depress the public and private conscience of Greeks in the latter half of the fifth century B.C. Similarly, we are told by Boccaccio that the plague of 1348 induced great depravity of morals at Florence. The *Decamerone* has the black death for its underplot, the tellers of the hundred tales being seven ladies and three gentlemen who had quitted Florence in order to avoid the pestilence. We learn that in England clerks were wanting to fill the vacant benefices, and that a multitude of illiterate persons were ordained to the cure of souls after the plague had devastated the country. It was noticed that the ancient learning and piety which characterised the monasteries of the thirteenth century was succeeded by a general dissoluteness and ignorance after the middle of the fourteenth. Oxford, which is said to have counted her students by thousands before the visitation, was almost deserted after it. The evils of the plague must have been far more serious in France, where, in addition to this calamity, a furious war was carried on, not only between the competitors for the French crown, but between the partizans, free lances, and condottieri, whom the rival monarchs summoned to their banners, and permitted to enrich themselves on the spoils of the miserable people. It was to shake off this intolerable misery that the uprising of the JACQUERIE was vainly attempted in 1358. The peasantry was everywhere reduced to submission, and forced into a state of still more abject servitude, from which indeed they escaped ultimately only by the Revolution and the continental war.

The English labourer was more fortunate. The great mortality of the black death immediately increased the wages of labour [LABOURERS, STATUTE OF], and effected a revolution in the tenure of land. It raised the price of all those articles of which the value depends mainly on the cost of production, as clothing,

tools, and the like, without affecting, in the same degree, those of which the quantity is not capable of indefinite increase, but for which the demand is so considerable as to render a rent possible from the land on which they are produced. Hence, with high rates of labour, low prices, comparatively speaking, of food, and increasing prices of such commodities the money value of which could not be affected in the least by any regulation, rents fell, and the old system of farming by bailiff was too unprofitable to be carried on any longer.

The black death made its appearance in the seaports of Dorsetshire on the 1st of August, 1348, and travelled slowly west and northwards, through Somerset and Wilts, to Bristol. To check its progress, Bristol was put under quarantine, but the precaution was ineffectual; the plague spread to Oxford, and reached London by the 1st of November. On the 1st of January it appeared in Norwich, and was carried northwards by the eastern route, which formed the chief northern highway in the middle ages. Later in the year, it attacked a Scotch army, which had made an inroad into England during the crisis. The invaders were overtaken by it, on their retreat, in the forest of Selkirk, and suffered as fully 'by the foul death of the English' (an oath which, it is said, became common among them) as the enemies whom they had assailed in the midst of their calamity.

The plague passed through France and Germany, having entered Europe by Marseilles and Avignon in the summer of 1348, and reached Poland in 1349. In the winter of this year it attacked Sweden and Norway by infection from England. It desolated Russia in 1351, and even passed on westwards to Iceland and Greenland. It thus took the circuit of the Mediterranean, and, unlike most plagues which have penetrated into the Western from the Eastern world, was checked, it seems, for a time by the barrier of the Caucasus. It broke out afresh in Rome in 1350, in consequence of an unwise invitation made to the Catholic population to celebrate a jubilee in the capital of Christendom. It is said, that, among the changes which took place by consequence of the convulsions of the earth's surface which accompanied this terrible visitation, vast icebergs formed on the coast of Greenland, and effectually shut out that country from Europeans for centuries afterwards.

This country was periodically ravaged by the Levant plague for hundreds of years after its first appearance. The last time in which it attacked England to any serious extent was in the well-known pestilence of 1663, when the greatest weight fell on London.

There was abundant reason for these losses, whenever an endemic, always most deadly at its first appearance, attacked mediæval England. Nothing, to our modern notions of cleanliness, could have been so effectual a hotbed of disease as the ancient homes of England. The people died by myriads, and we cannot wonder at it; living as they did in huts built of clay and wattles, of one story only, unpaved and unglazed, every condition which could provoke and foster disease was present.

It is impossible to calculate the losses. Numbers given by chroniclers are never trustworthy. The writer has looked through several documents which profess, being almost contemporaneous, to give the numbers who perished in several localities; but not the least reliance can be placed on the statements. All that we really know is, that in England, at least, the plague chiefly affected the poor.

The ravages made by plague and famine are rapidly compensated. Famine always, plague generally, affects the weaker and less capable members of the community; and the population having a tendency to increase up to the means of subsistence, the numbers of any nation which is affected by either of these calamities are increased in greater ratio after the disease has passed away. If at the time in which the plague affects the community the loss is sudden and great, the supply of labour is contracted, and wages suddenly rise. If at the same time the standard of living is raised, i.e. if, in other words, the mass of labourers will not work except at higher rates, or, again, abstain from marriage until they can secure such higher rates, the condition of the wage-taking classes may be permanently benefited, and their material position permanently enhanced. This was the case in a notable degree after the great plague of 1348.

Plague, Cattle. [MURRAIN; RINDERPEST.]

Plaid (Gael. plaide, *a blanket*). A striped or variegated cloth much worn by the Highlanders of Scotland, forming a prominent part of the national costume, and indicating, by its pattern and colour, the different Scottish clans.

Plain Chant. A term in ancient ecclesiastical music to signify the chief melody, which was confined within the natural sounds of the scale.

Plains (Lat. planus, *flat*). In Geography, the general term for all those parts of the dry land which cannot properly be called mountainous, and which compose by far the greater part of the earth's surface. Plains have different physical appearances according to their geographical position, and the peculiar characteristics of each have procured for them different names; thus we have the STEPPES of Asia, the DESERTS of Africa, the PAMPAS of South America, and the PRAIRIES or savannahs of North America.

Plaintiff (Lat. planctus, *a plaint* or *wail*). In Law, one who brings an action or suit against another.

Plakodine (Gr. πλακώδης, *flat*). A native sub-arsenide of nickel, occurring in tabular, attached, and sometimes intersecting crystals, of a bronze-yellow colour, at the Jungfer mine, near Müsen, in Siegen, Prussia.

Plan (Lat. planus, *flat*). In Architecture, this word is applied to the horizontal section of the walls, partitions, staircases, &c. of a building,

showing the disposition of the ground plot, and of the upper floors.

Plan of Comparison. In Fortification, a plan of the fortress and surrounding country, on which are expressed the distances of the principal points from a horizontal plane, supposed to pass through the highest or lowest points in the survey. This imaginary plane is called a *plane of comparison.*

Planaria (Lat. planus). The name of a genus of *Sterelmintha*, or Parenchymatous Intestinalia of Cuvier, which do not inhabit the interior of animal bodies, but closely resemble, in their organisation, the parasitic species of Trematode Entozoa. They retain the superficial vibratile cilia, and lead from this order to the Suctorious Anellides, or leeches.

Plane (Lat. planus). In Geometry, a surface without curvature; or, according to Euclid, it is a surface such that if any two points whatever in it be joined by a straight line, the whole of the straight line will be in the surface.

Plane of Defilade. In Fortification, a plane supposed to pass through the crest of a work, parallel to the plane of site.

Plane at Infinity. The plane in which we may conceive the infinitely distant points of space to be situated. [INFINITY.] The general equation of a plane is

$$Ax + By + Cz + D = 0,$$

where A, B, C, D are constants, of which the first three, being inversely proportional to the intercepts on the co-ordinate axes, vanish for the plane at infinity, and leave the anomalous relation $D = 0$, which must be regarded as the equation of the plane in question.

Plane Sailing. In Navigation, the art of determining the ship's place, on the supposition that she is moving on a plane, or that the surface of the ocean is plane instead of being spherical. This method of finding the ship's place is by the solution of a right-angled plane triangle. The part of the meridian between the ship and the parallel of latitude through the place to which the ship is bound is the base, the part of the intercepted parallel is the perpendicular, and the hypothenuse is the line joining the two places, and therefore called the distance; the angle between the base and the hypothenuse is the course. Of these four parts any two being given, the others may be found by the common rules of plane trigonometry. [NAVIGATION.]

Plane of Site. In Fortification, the general level of the ground on which a work is constructed, whether horizontal or inclined to the horizon.

Plane Table. An instrument employed in Land Surveying, by means of which a plan is made on the spot, without any protraction or measurement of angles. It consists of a plane rectangular board, about sixteen inches square, to the under side of which a centre is attached with a ball and socket, or parallel plate screws, by which it can be fixed upon a staff-head or three-legged stand, and set horizontal by means of a circular spirit level. A compass-box with a magnetic needle is screwed into one side of the table, to indicate the bearings, and to enable the surveyor to set up the instrument at a new station parallel to the position which it had at a former one. A brass rule or index, with a sloping edge, and having perpendicular sight-vanes erected at each extremity, completes the apparatus.

The plane table is used as follows: Two stations are selected as the extremities of a base line, the distance between them being accurately measured, and a line drawn on the paper, representing that distance according to the assumed scale. The instrument is then set up at one of the stations, and a fine needle or pin being stuck into the table, at one extremity of the line drawn on the paper, the edge of the index is brought to press gently on the pin and coincide with the line, and the table turned round till the object at the second station is bisected through the sight-vanes; the table is then clamped, and the direction of the magnetic meridian marked. The fiducial edge of the index, still in contact with the upright pin, which serves as a centre, is then directed successively to all the different objects which have been selected as stations, and lines drawn on the paper in the direction of each. This being done, the table is removed to the second station, and the pin placed at the corresponding point on the paper, which forms a second centre. The edge of the ruler is then directed, as before, to each of the objects which were observed from the first station, and lines drawn in those different directions. The intersections of the lines drawn from the second centre with those drawn from the first, mark on the paper the positions of the observed objects.

The plane table is not susceptible of great accuracy, but it is extremely useful in forming a sketch-map, or filling up the details of a survey, where the principal points have been fixed by the theodolite, or some equivalent instrument. [SURVEYING.]

Plane-tree. [PLATANUS.]

Planera (after J. S. Planer, a German botanist). A family of Asiatic and North American trees, closely related to Elms. The timber of *P. Richardi*, the Zelkona-tree, is much prized. The sapwood, which is of a light colour and very elastic, is used for the purposes in which ash-timber is employed; while the heartwood, which occupies two-thirds of the trunk, is reddish, heavy, and when dry exceedingly hard: hence it takes a good polish, and is valued for making domestic furniture.

Planerite. A newly described phosphate of alumina with oxides of copper, and iron, from Gumeschefsk in the Ural, where it occurs in the form of thin crusts coating fissures in quartzite.

Planet (Gr. ἀστὴρ πλανήτης, *wandering star*). The name given by the ancient Greeks to those bodies which constantly change their situation in the heavens, and thus appear to *wander* among the constellations. The discovery

of satellites and periodic comets has rendered it necessary to adopt a more precise definition, in order to individualise the class of objects to which the term is applied; and accordingly modern astronomers understand by the term *planet* a body which revolves about the sun in an elliptic orbit, not differing greatly from a circle.

The number of planets, including the earth, at present known to belong to the solar system, is ninety-three. Five of them—Mercury, Venus, Mars, Jupiter, and Saturn—have been known from the earliest ages of astronomy; Uranus was discovered by Sir William Herschel in 1781; Neptune by Adams and Leverrier in consequence of a theoretical indication in 1846. Ceres, one of a group of which eighty-five are at present known, was discovered by Piazzi, at Palermo, on the first day of the present century. Most of these last and Neptune are never visible to the naked eye; under favourable circumstances Uranus may be discerned without a telescope; and Mercury, though it appears as a large star, is seldom to be seen (in our latitude at least), in consequence of its proximity to the sun.

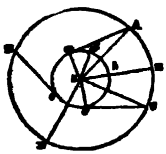
Of the apparent Motions of the Planets.—On watching the motions of any of the conspicuous planets for a few days or weeks, their change of position among the fixed stars becomes sufficiently apparent, even without the aid of an instrument to measure their relative distances. Their paths deviate little from that followed by the sun in his apparent annual revolution through the heavens; but their motions are exceedingly irregular. Sometimes they advance rapidly, then relax in their speed, come to a stop, and then move for a while in an opposite direction. Through the most considerable part of their orbits they move like the sun from west to east, in opposition to the apparent diurnal motion; their course is then said to be *direct*. When it lies in the opposite direction, their motion is *retrograde*; and between each change from the one direction to the other, they remain for a few days *stationary*. On the whole, however, the direct motion prevails, and the planets make the entire circuit of the heavens. These phenomena, which are called the *stations* and *retrogradations* of the planets, may be exhibited in the following manner: Let E C represent the ecliptic developed on a plane surface: the path of a planet, found by laying down its observed positions with reference to the ecliptic from day to day, will present the appearance of the zigzag line P Q R S. From P to Q the motion is direct, but becomes slower as the planet approaches to Q. At Q it is stationary; from Q to R retrograde; at R again stationary; from R to S direct, and so on. Such is the general character of the apparent motion; but the arcs and times of retrogradation differ greatly in respect of the different planets.

Mercury and Venus exhibit phenomena peculiar to themselves, inasmuch as they never appear in the opposite quarter of the heavens to the sun, but oscillate about the sun from side to side; the oscillations of the former being much quicker, and performed in a much smaller arc than those of the latter. The distance of Venus from the sun never exceeds an arc of about 47°; and at its greatest distance the planet does not continue above the horizon more than about three hours after sunset. Its brilliancy, however, is such, that it may frequently be seen in the morning several hours after the sun has risen. Mercury never recedes farther from the sun than 28° 20′, and does not appear above the horizon more than 1 h. 40 m. after sunset, or before sunrise. For these reasons, Mercury and Venus were regarded by some of the ancient astronomers as satellites of the sun, and supposed to describe orbits round that luminary. The other planets, Mars, Jupiter, and Saturn, being
seen in opposition to the sun, and
ferent distances from it, were supposed to have independent motions.

In order to explain and represent the apparent motions of the planets, the ancient astronomers had imagined various hypotheses, of which the most celebrated is that of epicycles and deferents, invented by the geometer Apollonius; and adopted by Ptolemy, after whom it was called the PTOLEMAIC SYSTEM of the universe, and implicitly believed in during many centuries. According to this hypothesis, each planet moves uniformly in a small circle, called the *epicycle*, the centre of which is carried along, with a uniform motion, in the circumference of another large circle, called the *deferent*, which has the earth at its centre. [EPICYCLE.] By supposing the velocity of the planet in its epicycle to be greater than that with which the centre of the epicycle is carried along the deferent, and by assigning proper relations between the lengths of the radii of the epicycles and deferent circles (their absolute lengths are immaterial), the apparent geocentric motions may be represented with all the exactness of which the ancient observations admitted. Ptolemy placed the earth at the centre of the universe, and nearest to it the moon. Next to the moon was Mercury, then Venus, then the sun; after which followed in order Mars, Jupiter, and Saturn; the distance of the three last being arranged according to their respective periods of revolution; it being natural to suppose that those which required the longest time to complete their periods must revolve in the widest circles. At the present day, and familiar as we now are with the true nature of the celestial motions, this complicated system appears abundantly absurd; but it should be recollected that Ptolemy possessed no means of forming any accurate notions of the distances of the planets: he was unacquainted with the alternate increase and diminution of their apparent diameters, with the phases of Venus, and all the other information afforded by the

telescope; in short, he knew of no phenomenon which could not be reconciled to his theory; and he does not appear to have ever regarded his system of epicycles and deferents in any other light than a mere hypothesis, by means of which the celestial motions could be reduced to calculation.

All the apparent irregularities of the planetary movements are got rid of at once by referring them to the sun as a centre, instead of the earth. This great step in theoretical astronomy was made by Copernicus, who first demonstrated that all the phenomena were explicable in the simplest manner by supposing the sun to be placed at the common centre of the planetary motions, and ascribing to the earth a double motion; namely, a diurnal rotation about its axis, and an annual revolution about the sun. On this hypothesis, which produced no fruit when put forth by Aristarchus of Samos [Heliocentric System], but the truth of which has been established by a multitude of different considerations, the stations and retrogradations of the planets, and all the geocentric appearances which so much perplexed the ancient astronomers, become simple consequences of relative motion. In order to illustrate this, let us consider the appearances which must result from the combined motions of the earth and an *inferior* planet; i.e. a planet nearer to the sun than the earth is.



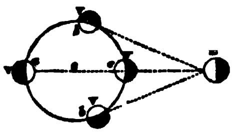
Let S be the sun, A B C D the orbit of the earth, and *a b c d* that of Mercury, both moving in the same direction, or in the order of the letters. Suppose A to be the position of the earth, and *a* that of Mercury at its greatest eastern elongation: the line A *a* is a tangent to the orbit at *a*. As the earth advances from A towards B, and the planet from *a* towards *b*, the angle of elongation S A *a* will continue to diminish, till the earth arrives at a certain point B, when the planet is at *b* in the same straight line with the earth and the sun, the angles A S B and *a* S *b* described by the earth and the planet being proportional to the respective mean angular motions. In this situation the planet is said to be at its *inferior conjunction*. When the earth has passed B, the planet, which travels in its orbit with a more rapid angular motion than the earth, will begin to appear on the western side of the sun, and the angle of elongation continue to increase, till the planet arrives at *c*, and the earth at C, where the visual line is again a tangent to the orbit. The angle of elongation has now attained a second time its maximum value, and from this point will continue to decrease, till it vanishes altogether when the earth arrives at D and the planet at *d*, the three points D S and *d* being in the same straight line. The planet is now at its *superior conjunction* and *beyond* the sun. Soon after this the planet reappears on the eastern side of the sun; and the angle of elongation continues to increase till the planet comes round to *a*, and the earth arrives at E, where the line E *a* is again a tangent to the orbit. The earth, the planet, and the sun have now precisely the same relative situations in respect of each other as they had when the earth was at A and the planet at *a*, so that the series of changes will here recommence and proceed in the same order as before. The intervals after which these phenomena occur may be easily computed from a knowledge of the periods of revolution of the earth and the planet, and of the proportion of the radii of their respective orbits, which is, moreover, known immediately from the observed angle of greatest elongation S A *a*; for, since S *a* A is a right angle, we have S A to S *a* as radius to the cosine of S A *a*: that is, the radius of the planet's orbit is equal to the radius of the earth's orbit multiplied by the cosine angle of greatest elongation.

From the preceding figure, it is easy to see how the phenomena of the stations and retrogradations must arise. At the point *b*, where the planet is at its inferior conjunction, the earth and planet are both moving in the same direction; but, as the planet is moving faster, it will leave the earth behind it; and the apparent motion, as seen from the earth, will be the same as if the planet stood still, and the earth moved in a contrary direction, with a velocity equal to the difference of their relative motions. The apparent motion of the planet is therefore contrary to the apparent motion of the sun amongst the stars, and consequently retrograde. At the superior conjunction *d*, the planet and earth are moving in opposite directions in respect of the line D *d*; the relative motion is therefore the same as if the planet stood still, and the earth was moving in its proper direction with a velocity equal to their united motions: the apparent motion of the planet in this situation is therefore direct. At the points of greatest elongation, *a* and *c*, the planet is moving in the direction of the line of vision, A *a* or C *c*, and the earth perpendicular (nearly) to that line; the apparent motion of the planet at those points is therefore direct. But since it is direct at *a* and *c*, and retrograde at *b*, there must be a point between *a* and *b*, and another between *b* and *c*, where the apparent motion is neither direct nor retrograde, i.e. where the planet appears stationary. The problem of determining the stationary points is one of pure geometry, and very easily resolved when the orbits are supposed to be circular, and the motions uniform; but, in the case of elliptic orbits and unequable motion, it is considerably more complicated. The stationary points of Mercury are variable from 15° to 20° of elongation from the sun; those of Venus are about 29°. Mercury continues to retrograde about twenty-two days, Venus about forty-two.

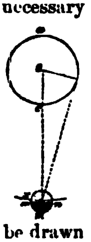
The apparent motions of the *superior* planets, or those which are at a greater distance from

the sun than the earth is, are explained with equal facility. As their orbits embrace that of the earth, they are not confined to certain limits of elongation from the sun, but appear at all distances from it, even in the directly opposite quarter of the heavens. When they are in *conjunction*, they are situated beyond the sun, in the same plane, vertical with regard to the ecliptic, with the sun and earth; and when the earth comes between them and the sun, they are said to be in *opposition*. All the superior planets, when in opposition, and for some time before and after, appear to have a retrograde motion; but the extent of the arc of retrogradation, the time during which the motion is retrograde, and the velocity, are very different in respect of the different planets. Mars continues to retrograde about 73 days, Jupiter 121, and Saturn 138.

Phases of the Planets.—It is a necessary consequence of the Copernican theory, that the planets, supposing them to be, like the earth, round, opaque bodies illuminated by the sun, must exhibit phases like the moon, according to the angles under which the illuminated half of their surfaces is seen from the earth. When viewed through the telescope, this is found to be the case with Mercury and Venus, and to a certain extent also with Mars; and the appearance of the phase is in every case exactly such as is determined à priori, on the supposition that the planet is seen by the reflected light of the sun. Let S be the sun, E the earth, and V Venus, in different positions of her orbit. When the planet is at its superior conjunction *a*, the whole of its illuminated surface is seen from the earth, and it consequently exhibits a round disc. At the points of greatest elongation, *b* and *b*, one half only of the illuminated hemisphere is visible, and it therefore appears half-mooned at these points. At *c*, the inferior conjunction, the dark side is turned directly to the earth, and it is consequently invisible. Between *a* and *b*, the planet will therefore appear gibbous (i.e. more than the half full); and between *b* and *c* it will appear in the form of a crescent, like the moon in its first or last quarter. The phases of Mercury are precisely similar. With respect to the superior planets, the absence of phases is a necessary consequence of their great distances



from the sun in comparison of the earth's distance. Let S be the sun, E the earth, and M Mars. It is evident that, as the earth goes round in its orbit, the smallest portion of the enlightened hemisphere, *m x n*, will be visible when the earth is at E, or in such a position that the angle S E M is a right angle. Suppose a line, therefore, to be drawn from the centre of the planet perpendicular to E M, and intersecting the surface in *x*, the visible surface will be contained between *x* and *n*, so that the disc will appear to be gibbous, but can never appear as a crescent.

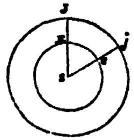


Distances and Periodic Times of the Planets.—Practical astronomy furnishes various methods of determining the distances of the planets from the sun in terms of the earth's distance, and the times in which they complete their revolutions. It has already been stated, that the distances of Mercury and Venus may be compared with that of the earth by observing the angle of greatest elongation. In the case of a superior planet, an approximation to the relative length of the *radius vector* (the line which joins the planet with the sun) may be obtained by observing the angular velocity of its apparent retrogradation about the time when it is in opposition. Thus, conceive E *e* to be a small portion of the earth's orbit described in a given interval of time, a day, for example, and M *m* to be the corresponding portion of the orbit of Mars described in the same interval, the planet being near the opposition. Join *e m*, and draw *e n* parallel to S M. As seen from *e*, Mars will appear to have retrograded from *n* to *m*; therefore the angle *n e m* is given by observation, and consequently its complement *m e* E becomes known (for the arc E *e*, being very small, may be regarded as a straight line). Now, in the triangle *e* S E, right-angled at E, the angle at S is given, being the angle described by the radius vector of the earth in the given interval; consequently the angle S *e* E becomes known, and hence also S *e m*. Supposing, therefore, the periodic time of Mars to be known, the arc M *m*, or the angle M S *m*, will be given; and therefore *m* S *e*, which is its difference from E S *e*, becomes known. In the triangle S *e m*, we have therefore given the two angles S *e m* and *e* S *m*, and consequently also the third angle *e m* S, whence the triangle is given in species, and the ratio of S *e* to S *m* is determined. But S *m* is the distance of Mars from the sun, which, therefore, is determined in terms of the radius vector of the earth.

The method of finding the planet's distance, which has just been described, requires that the periodic time be previously known. There are various methods of determining the periodic time, independently of a knowledge of the distance of the planet from the earth. One of the most convenient consists in depending on a minute motion of the node, and which in a general view of the subject may be disregarded.

Another and more convenient method of finding the period of a superior planet consists in determining, from the observations of a few consecutive days, the exact time at which it is in opposition to the sun. At this instant the longitude of the planet is 180°, and on the day of the opposition it passes the meridian twelve hours after the sun. The interval between two successive returns to the opposition is the *synodic* period of the planet; this differs very considerably from the sidereal period, but the

latter is easily deduced from it. Let E and J be the positions of the earth and Jupiter, when Jupiter is in opposition. The next opposition will take place after the earth has made a complete revolution, together with a certain arc E e, which we shall call x, corresponding to Jupiter's angular motion in the interval. Now the number of days between the two oppositions, or the synodic period, is known: call this $365+t$; then the time in which the arc E e or x has been described becomes t days. We have therefore



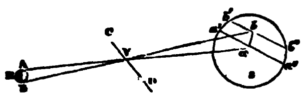
$$365 : t :: 360^\circ : x;$$

whence x, or the angle J S j, is known. But, if p denote the sidereal period, we shall have $x : 360^\circ :: t : p$, and therefore $p = \frac{360\,t}{x}$. On account of the orbits not being exactly circular, these intervals are not quite equal; but by taking the average of a considerable number of observed oppositions, the inequalities disappear, and the mean synodic periods (and consequently the sidereal periods) are obtained with the utmost accuracy.

Relations between the Periods and Distances.—On comparing the columns giving the periods and distances of the planets in the following table, the idea of a certain relation between the periods and distances cannot fail to suggest itself, as they both increase in a tolerably regular progression (the small planets between Mars and Jupiter being left out of the question), though the periods increase in a much more rapid proportion than the distances. Jupiter, for example, is five times more distant from the sun than the earth is, but his period is nearly twelve times that of the earth. Kepler, the great founder of physical astronomy, undertook to investigate the analogy; and, after a most laborious comparison of the numbers (and their various powers) representing the periodic times and the mean distances of the six planets known in his age, discovered this most remarkable law: 'That the squares of the periodic times of any two planets are to each other in the same proportion as the cubes of their mean distances from the sun.' [KEPLER'S LAWS.] Taking, for example, the earth and Mars, whose periods are respectively 365·256 and 686·979 days, and distances in the proportion of 1 and 1·5237, it will be found that $(365{\cdot}256)^2 : (686{\cdot}979)^2 :: 1 : (1{\cdot}5237)^3$, very nearly. Nor is this merely an empirical relation, deduced from observed facts, but not referable to any known cause: on the contrary, it is a necessary result of the law of gravitation, and pregnant with important consequences. From its being observed in the planetary system, it follows that all the planets are bodies of the same kind as the earth, and that they are all acted upon in the same manner by the solar attraction (modified only by the distance), which alone determines their periods, and retains them in their orbits.

Real Dimensions of the Planetary Orbits.—Hitherto we have spoken only of the relative distances of the planets from the sun; but it is interesting to determine what these distances actually are in terms of some measure with which we are familiarly acquainted. In consequence of Kepler's law of the relation between the periods and distances, if the real dimensions of any one orbit be ascertained, those of all the other orbits will be found immediately when the periodic times of the planets are respectively known. In fact, the dimensions of the orbits having been already stated in terms of that of the earth, it is only necessary to find the earth's distance from the sun, in order to find the respective distances of all of them. Now, to find the earth's distance from the sun is the same thing as to find the sun's horizontal parallax, that is the angle which the radius of the earth would subtend if seen from the sun; for the determination of that angle gives the relation between the earth's distance and its semi-diameter, which is known from the actual measurement of degrees of the terrestrial meridian. Of the various methods which astronomers possess of determining the sun's horizontal parallax, the most accurate is that which depends on observations of the transits of Venus over the sun's disc; a phenomenon, however, of very rare occurrence, so that the method can very seldom be practised.

When Venus is at her inferior conjunction, and at the same time very near one of her nodes, the planet will be projected on the disc of the sun; and through the effect of her proper motion, combined with that of the earth, will be seen as a black spot to pass over, or *transit*, the solar disc, describing a chord which will be referred to different positions on the disc by observers stationed at different points on the earth's surface. Let E be the earth, V Venus, S the sun, and CD a portion of Venus's orbit, described while she is transiting the sun's disc. Suppose A and B to be the two opposite extremities of the earth's diameter, which is perpendicular to the ecliptic: a spectator at A would see the centre of Venus projected on the sun's disc at a, and describing in her successive positions the chord $a'\,a\,a''$; while a spectator placed at B would, at the same instant, see her projected on the disc at b, and describing the chord $b'\,b\,b''$. Now it is evident that if there be any means of measuring the distance between the two chords $a'\,a''$ and $b'\,b''$, or the line $a\,b$, that distance will give the sun's horizontal parallax; for the two triangles A V B and a V b being similar, $a\,b$ is to A B as a V to A V, or as the distance of Venus from the sun is to the distance of Venus from the earth. But the



relative distances of the earth and Venus from the sun are known; therefore the ratio of a V to A V is known, and consequently that of $a\,b$ to A B. This ratio is that of 68 to 27, or $2\frac{1}{2}$ to 1 (very nearly); therefore the distance $a\,b$, as seen from the earth is $2\frac{1}{2}$ times greater than A B as seen from the sun, or, which is the same thing, equal to 5 times the sun's horizontal parallax. The whole difficulty of the problem, therefore, consists in determining the distance of the two chords $a'\,a''$ and $b'\,b''$, or their relative positions on the sun's disc, from which their distance can be deduced. One of the best ways of accomplishing this is to note, with great accuracy, the instants at which Venus enters and emerges from the solar disc, so as to obtain the exact time occupied in the transit; for the relative motion of Venus being accurately known, the time occupied in the transit gives the length of the chord described; and the sun's apparent diameter being also known, the arcs cut off by $a'\,a''$ and $b'\,b''$ are thus found, and the difference between the versed sines of those arcs is evidently the distance between the chords, or the line $a\,b$. The problem, however, is rendered much more complicated by the earth's rotation, and other circumstances here neglected, of which it is unnecessary to take account in a general explanation.

The transit of Venus which took place in 1769, was the occasion of the first of the celebrated voyages of Captain Cook to Otaheite. It was observed at Otaheite, at Wardhus in Norway, at Cajaneburg, and Kola in Lapland; at Petersburg, Paris, California, Hudson's Bay, &c. The general result of all the observations, as discussed by Encke, gave the sun's horizontal parallax equal to 8·5776″. Hence, the sun's distance is given in terms of the earth's radius by the proportion

sin 8·5776″ : radius :: radius of earth : sun's distance;

whence, on reducing the radius of a circle to seconds, we have the sun's distance

$$=\frac{360 \times 60 \times 60}{8{\cdot}5776 \times 2 \times 3{\cdot}14159}$$

= 24,047 terrestrial radii. Assuming the earth's semidiameter [EARTH] to be 4,000 miles in round numbers, the sun's distance from the earth will therefore be

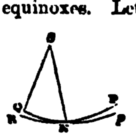
$$24{,}047 \times 4{,}000 = 96{,}188{,}000,$$

or about ninety-six millions of English miles. Now-a-days, however, we are no longer so entirely dependent upon a transit of Venus as we were, and it is certain that the sun's distance, as stated above, requires to be notably diminished. Several independent investigations go to show that a correction should be applied to the sun's parallax as determined by Bessel, equivalent to the breadth of a human hair viewed at the distance of 125 feet: a small alteration truly, but one which reduces the sun's distance some three millions of miles, and of course the distances of the planets in proportion. [SUN.]

This application of the transits of the inferior planets to the important purpose of determining the sun's distance from the earth was first by James Gregory, in his *Optica tæ*, published in 1663. Those of Venus recur after intervals of 113 years; but as Venus returns to her conjunction at nearly the same point of her orbit in about eight years, and the difference of her latitude at two successive conjunctions amounts only to 20′ or 24′, which is less than the sun's diameter, it will generally happen that two transits take place within eight years; the first before the planet has passed the node, and the second after the passage of the node. But three transits cannot take place within 16 years; hence, after two transits have occurred within 8 years, another cannot be expected before 105, that is, 113 − 8 years, and may not happen until after 121 years. The two last transits took place in 1761 and 1769; the next two will take place in 1874 and 1882; after which there will not be another till 2004. By reason of the small distance of Mercury from the sun, the difference between his horizontal parallax and that of the sun cannot be so accurately ascertained: and hence the transits of that planet, though of more frequent occurrence than those of Venus, cannot be employed with such certainty in determining the sun's parallax.

Having found the mean distance of the earth from the sun in terms of a known unit, the mean distances of all the other planets from the sun, the ratios of which to that of the earth were given above, may be expressed in the same terms. They can be found from the accompanying table by multiplying by either unit of distance.

Inclination and Nodes of the Planetary Orbits.—The planes of the planetary orbits are inclined to each other under different angles, and, in determining the circumstances of a planet's motion, one of the first steps to be taken is to fix the situation in space of the plane in which it moves. For this purpose, it is necessary to refer it to some other plane whose situation is assumed to be known. The plane of the ecliptic is that to which we naturally refer the bodies of the solar system, and the line of the equinoxes is taken as the origin of angular reckoning in that plane. Hence, to determine the position in space of the plane of a planet's orbit, we must determine its inclination to the ecliptic, and the position of the line in which it intersects the ecliptic with respect to the line of the equinoxes. Let S be the sun, P N R the orbit of a planet, and p N Q the projection of that orbit on the plane of the ecliptic, intersecting the line of the equinoxes S Q in Q; then Q is the point from which the longitudes are reckoned, N is the node, S N the line of the nodes, or line in which the plane of the orbit intersects the

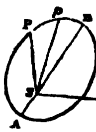


ecliptic, the angle Q S N the longitude of the node as seen from the sun, and P N *p* the inclination of the orbit. If R be supposed to be on the south side of the ecliptic, and P on the north side, and the planet's motion to be in the direction R P, then N is the *ascending* node. The place of the node is determined by observing the planet when its latitude is very nearly equal to nothing; and the equinoctial point Q being known, the *geocentric* longitude of the node (the angle formed by drawing straight lines from Q and N to the earth) is determined by observation; whence there are sufficient data for computing, by a trigonometrical process, the *heliocentric* longitude Q S N, and also the inclination P N *p*. The places of the nodes are not absolutely fixed. In consequence of the mutual attractions of the planets to each other, they have a slow retrograde motion in respect of the fixed stars. The inclinations are also subject to a slight variation, but so small as to amount at most to a few seconds in a century. Hence, in mentioning the longitudes of the nodes, and the inclinations of the orbits, it is necessary to state the epoch to which the values refer. In the table on the opposite page the values correspond to Jan. 1, 1800. We find that while the major planets revolve in planes not widely differing from that of the earth, some of the orbits of the minor planets are largely inclined, and on this account, as well as in their great eccentricity, resemble comets.

The ancients gave the name of *zodiac* to that zone of the heavens within which the planets were observed to move, and which, consequently, had a breadth of 14°, or twice the inclination of the orbit of Mercury. As the inclinations of many of the minor planets are greater than that of Mercury, they traverse the heavens lying outside the zodiac, and hence have been named *extra-zodiacal* planets.

Figures of the Planetary Orbits.—When the inclination of a planet's orbit and the situation of the line of the nodes have been determined, the radius vector of the planet, at any instant, may be computed in terms of the sun's distance from the earth, from the planet's latitude and longitude found by a single observation. By computing, therefore, the values of its radius vector at a great many different points of the orbit, and laying down each on paper at the proper angle of elongation round the sun, the form of the orbit which the planet describes will be ascertained. A few observations of this sort will show that the radius vector varies in length, and, consequently, that the orbit is eccentric. This fact was known from the time of Hipparchus; but the true form of the planetary orbits was not discovered till Kepler found, by a laborious computation of the distances of Mars at its oppositions, from the observations of Tycho Brahe, that the orbit of that planet is an ellipse. He subsequently found the same thing to be true of the orbit of the earth, and of the other planets then known; and hence established the first of those important laws respecting the planetary motions which still go by his name, viz. that the orbits of all the planets are ellipses, of which the sun occupies one of the foci. [KEPLER'S LAWS.]

The same observations which show the orbit to be an ellipse will also serve for the determination of its eccentricity, which is half the difference between its greatest and least distances. The only element which then requires to be known, in order to fix the path described by the planet in space, is the position of the orbit on its plane, or the situation of its transverse axis with respect to the line of the equinoxes. Let A P B be the projection of an orbit on the plane of the ecliptic, A B its transverse axis, and S Q the line of the equinoxes, S being the focus occupied by the sun. The point A is the *perihelion* of the orbit, and B the *aphelion*; the line A B is the line of the *apsides*; and the position of A B with respect to S Q will be known by means of one of the angles Q S A or Q S B, which are respectively the longitudes of these points. In modern tables, the angle Q S A, or *longitude of the perihelion*, is that whose value is given. The eccentricities of all the planets are subject to a very small secular variation: the line of the apsides is also in a state of continual but slow revolution, so that the perihelia are gradually shifting their places on the planes of the orbits. In the case of all the planets excepting Venus, the motion of the line of the apsides is direct; that is to say, it is in the same direction as the motion of the planet in its orbit. The perihelion of Venus, referred to the fixed stars, moves in a contrary direction. The accompanying table shows the eccentricities and longitudes of the perihelia of the different planets.



Motion of the Planets in their Orbits.—When the six elements, the numerical values of which are given in the annexed table, viz. the mean distance and periodic time; the inclination of the orbit; the longitude of the node; the eccentricity, and longitude of the perihelion; have been determined for each planet, it will be possible to compute the position of a planet in its orbit, provided we know the law according to which the planet moves at every point of the orbit, and also the instant of time at which it occupies any given point. The motion in the orbit is given by the second of Kepler's laws; viz. 'The areas described by the radius vector are proportional to the times employed in describing them.' Thus, if the planet has moved from A to P (see the preceding figure), or the radius vector S P has described the area A S P in the time t, and the area A S p in the time t'; then $t : t' ::$ sector P S A : sector p S A. The problem which proposes to find the point P, or the angle A S P (which is called the *true anomaly*), from the condition that the area A S P shall be to the whole ellipse as the given time in which A P is described is to the time of a

ELEMENTS OF THE PLANETS.

Units { Earth's Mean Distance from the Sun { Old Value (Sun's Parallax), 8″·5776 = 95,274,000 Miles.
New Value " 8″·9159 = 91,678,000 "
" Mass, 6,069,000,000,000,000,000,000 Tons.
" Density, that of Water as 1 = 5·6747.
" Volume, 259,800,000,000 Cubic Miles.

REVOLUTION

Symbol	Name	Distance from the Sun: Mean	Distance from the Sun: Greatest	Distance from the Sun: Least	Excentricity (half major axis as unity) e 1800	Longitude of Perihelion ϖ 1800	Longitude of Ascending Node ☊ 1800	Inclination of Orbit to Plane of Ecliptic ι 1800	Sidereal Revolution, mean Solar Days	Synodic Revolution, mean Solar Days	Mean Hourly Motion in Orbit	Mean Daily Motion in Orbit
						° ′ ″	° ′ ″	° ′ ″			Miles	′ ″
☿	Mercury	0·387098	0·466692	0·307504	0·2056003	74 20 77·57	45 57 38·7	7 0 4·51	87·9692824	115·877	100·000	245 32·6
♀	Venus	0·723331	0·728263	0·718399	0·0068590	128 42 48·3	74 52 58	3 23 28·1	224·7007754	583·902	80·000	96 7·8
♀ or ⊖	Earth	1·000000	1·016775	0·983224	0·0167920	99 30 21·77	— — —	— — —	365·2563744	—	68·000	59 8·3
♂	Mars	1·523691	1·665779	1·381602	0·0932168	332 22 53·66	48 0 46·	1 51 5·8	686·9794561	779·936	55·000	31 26·7
♃	Jupiter	5·202767	5·453663	4·951871	0·0481594	11 7 37·69	98 26 34·4	1 18 52·06	4332·5848042	398·867	30·000	4 59·3
♄	Saturn	9·538850	10·073278	9·004422	0·0561563	89 7 45·40	111 56 15·7	2 29 35·89	10759·2197106	378·090	22·000	2 0·6
♅	Uranus	19·182390	20·076300	18·288480	0·0466109	167 30 22·62	72 59 14·1	0 46 28·44	30686·8205556	369·656	15·600	0 42·4
♆	Neptune	30·036270	30·298160	29·774380	0·0091709	49 34 17·4	129 34 46·7	1 47 17·8	60126·722	367·488	12·700	0 21·6

Name	Rotation: Time (Mean Solar)	Rotation: Inclination of Equator to Orbit	Rotation: Ascending Node of Equator to Orbit	Equatorial Diameter: Old Value	Equatorial Diameter: New Value Parallax 8·90″	Polar Compression	Mass: Sun = 1	Mass: Earth = 1	Force of Gravity at Equator	Bodies fall in One Second	Density and Volume: Density	Density and Volume: Volume	Intensity of Sun's Light and Heat, Earth's = 1	Apparent Diameter as seen from Earth: Max.	Apparent Diameter as seen from Earth: Min.	Equatorial Semidiameter at the Mean Distance of the Earth from the Sun
	h. m. s.	° ′ ″	° ′ ″											″	″	
Mercury	24 5	?	?	2950	3067	$\frac{1}{150}$	$\frac{1}{4865751}$	0·073	0·48	7·7	1·225	0·0595	6·674	11·5	4·5	3·34
Venus	23 16 19·0	49 58 9	50 30 0	7800	7814	?	$\frac{1}{401911}$	0·996	0·90	14·5	0·908	0·9960	1·911	62·0	9·5	8·305
Earth	23 56 4	23 27 24·2	90 0 0	Mean	7901	$\frac{1}{299}$	$\frac{1}{354936}$	1·000	1·00	16·1	1·000	1·0000	1·000	—	—	—
Mars	24 37 23	21 51 0	79 1 0	4118	4178	$\frac{1}{50}$	$\frac{1}{2680337}$	0·132	0·49	7·9	0·972	0·1364	0·431	23·5	3·3	5·55
Jupiter	9 55 26	3 4 0	313 22 0	89208	87890	$\frac{1}{17}$	$\frac{1}{1047·87}$	338·718	2·45	39·4	0·227	1491·0000	0·036	46·0	30·0	99·704
Saturn	10 29 17	26 49 0	171 43 35	77230	74327	$\frac{1}{10}$	$\frac{1}{3501·6}$	101·364	1·09	17·6	0·131	772·0000	0·011	20·5	14·6	81·106
Uranus	?	100 30 0	165 15 0	34500	33200	$\frac{1}{5}$	$\frac{1}{24900}$	14·251	0·76	12·3	0·167	86·5000	0·003	4·3	3·5	37·25
Neptune	?	?	?	37500	36100	?	$\frac{1}{18780}$	18·900	1·36	21·8	0·321	76·6000	0·001	2·7	2·6	?

whole revolution, is important in practical astronomy, and known by the name of KEPLER'S PROBLEM.

Magnitudes and Rotations of the Planets.—When the planets are examined through powerful telescopes, they are seen to be round bodies, having measurable, and even considerable, apparent diameters. The distance of a planet being known, if the visual angle subtended by its diameter be measured by the micrometer, the real magnitude of its diameter will be discovered. In this manner it is found that all the planets are incomparably smaller than the sun, though some of them are vastly larger than the earth. The diameter of Jupiter, for instance, is eleven times greater than that of the earth. That of Saturn is little less considerable. The surfaces of the larger planets are seen to be diversified by dark patches or spots, from the attentive observation of which it is found that they resemble the earth in having a rotation about their own axes. Mars revolves about its axis in nearly the same time as the earth: Jupiter and Saturn in less than half that time. Of the rotation of Mercury, Venus, Uranus, and Neptune, nothing is yet certainly known; that of the second named has often been given, but modern observations have not confirmed it; Mercury is too brilliant, and Uranus and Neptune too far away, to enable the movement of their surface-markings to be observed. The small planets between Mars and Jupiter are so small and indistinctly seen, that their diameters cannot be accurately measured, and their periods of rotation are unknown. Pallas, considered to be the largest of them, was supposed by Sir William Herschel to have a diameter of only eighty English miles.

Telescopic observation of the planets within our reach has not only informed us of their real diameters and the elements of their rotation, but has revealed to us much of their physical constitution. Thus, as is more fully described in the detailed accounts of the various bodies, we know that Mars is an earth in miniature, with lands and seas, clouds and winter snows, like our own; that Jupiter and Saturn are also enveloped in atmospheres in which currents are continually at work; and that Venus also may much resemble our own planet. Thus we have in them at all events some terrestrial life conditions, though others depending upon mass, as shown in the accompanying table, are widely different. Nor are we now wholly dependent upon the existence of phases for our knowledge that the planets, like the moon, receive their light from the sun, for spectrum analysis has demonstrated that all the lines in the solar spectrum are present in the planetary spectra plus other absorption lines, telling us of absorption produced by the planets' atmospheres. [MARS.] The speculations on the sun's constitution now going on will doubtless throw much light upon planetary physics, and possibly connect the appearances and life conditions of a planet much more intimately with the quantity of original heat retained at any given epoch, than has hitherto been done. In the same manner geological investigations will prove a valuable aid to planetary astronomy.

The force which retains the planets in their orbits is the attraction of the sun: and, if they were acted upon by no other force, the laws of Kepler would be accurately observed, and the elements of their orbits would remain invariable. But each planet exercises an attracting force on every other, in consequence of which their motions, though principally obedient to the predominating influence of the sun, are affected by a number of forces of which the intensities and directions are perpetually changing. Hence all the elements of the orbits, their magnitudes and forms, their inclinations to the ecliptic, and their positions in their planes, are in a state of constant oscillation; fluctuating, however, between certain mean values from which they never greatly depart. [GRAVITATION; PERTURBATION.]

Hypothesis of Laplace, respecting the Formation of the Planetary System.—The motion of the planets in elliptic orbits, and the relation between their periods and distances, are necessary consequences of the law of gravitation which prevails throughout the universe; but the solar system presents several remarkable phenomena of which gravitation fails to give any account, which cannot be supposed to be the effect of accident, and which lead almost irresistibly to the conclusion that all the bodies which belong to it have had a common origin, and been formed under the agency of the same mechanical laws. All the planets as well as satellites, with one or two exceptions, move in the same direction, from west to east. The orbits of all the large planets are situated very nearly in the plane of the ecliptic; and, so far as has been discovered, they all revolve about their axes in the same direction, also from west to east. To account for these phenomena, Laplace has hazarded the speculation that all the planets and satellites have had their origin in the solar atmosphere, which he supposes to have extended beyond the orbits of the most distant planets, and to have undergone a progressive contraction by the radiation of heat into the stellar spaces. Now—as the solar atmosphere partakes of the sun's rotation about his axis, and in fact may be regarded as part of his mass—in proportion as its limits are contracted by cooling, the rotatory motion must increase, according to a well-known principle of mechanics; and the centrifugal force thus becoming greater, the point or limit at which it is balanced by gravity approaches nearer the centre. Supposing, therefore, the atmosphere to have extended to this limit at any epoch, it must, in cooling, have abandoned the molecules situated there and at the different limits successively produced by the increased velocity of the sun's rotation. This effect, however, would only take place at the equator; for on the parallels of latitude the centrifugal would not

equal the attractive force. Thus, zones of vapours would continue to be abandoned at the equator; and if the condensation of the molecules of these zones continued without any disunion taking place, the matter would, in the long run, form a solid or liquid ring, circulating about the sun in the plane of his equator. But the uniformity which would be necessary for the production of this effect, both in all the parts of the zone and in the cooling, must render such a phenomenon extremely rare. In fact, the ring of Saturn is the only instance of it in the planetary system. In almost every case each zone of vapours must have been broken up into numerous masses, which, moving with nearly the same velocities, would continue to circulate about the sun, nearly at the same distances. These separate masses would assume the spheroidal form, with a motion of rotation in the same direction as their revolving motion: in short, they would become so many planets in the state of vapour. But if any one of them was considerably larger than the rest, it would finally by its attraction unite all the others about its centre; and thus the zone originally abandoned would be transformed into a single spheroidal mass of vapours, circulating about the sun. This latter case must have been the most common. An instance, however, of permanent separation occurs in the group of small planets between Mars and Jupiter.

Conceiving the planet to have been detached from the solar atmosphere in the manner now described, the further cooling would occasion a nucleus to be formed at its centre which would progressively increase by the condensation of the vapours surrounding it. The condition of the planet would now perfectly resemble that of the sun, and consequently similar results would follow from the continuance of the condensation. Hence the formation of the satellites from the atmospheres of the planets, as the planets are formed from that of the sun.

This hypothesis of Laplace does not explain the origin of the comets, which we now know are small aggregations of matter excessively diffused, with an incandescent gaseous nucleus. Whatever may be the ultimate fate of the hypothesis (and each successive discovery renders it more probable), it must be allowed the merit of assigning a mechanical cause for some of the most remarkable phenomena of the universe, without invoking the aid of any other force than that of gravity—a property which belongs to matter in every form. The accompanying table, contributed by Mr. Lockyer to *The Heavens*, from which it is borrowed, gives the various planetary elements as they have been most recently determined. For further information the articles on the various planets should be referred to. [ASTRONOMY; SATELLITE; STAR; SUN.]

Planets, Minor. [ASTRONOMY.]

Planetarium. A machine for exhibiting the relative motions of the planets, and their positions in respect of the sun. [ORRERY.]

Planetary Astronomy. That branch of astronomy which treats of PLANETS [which see].

Planetary Nebulae. [NEBULÆ.]

Planing Machine. A tool employed for the purpose of giving a perfectly plane face to iron, stone, or wood. Such engines consist, for the most part, of cutters moving horizontally, or with a rotary motion, fixed in a frame carried over the substance to be operated upon. A good description of the best varieties of planing engines is a desideratum in scientific literature; but a notice of some varieties of them is given in the *English Encyclopædia*, division Arts and Sciences,' vol. vi.

Planipennates (Lat. planus, *flat*; penna, *a feather*). The name of a tribe of Neuropterous insects, comprehending those which have flat wings, of which the inferior pair almost equal the superior ones, and are simply folded underneath at their anterior margin. The antennæ are multiarticulate, much longer than the head, without being subulate or styliform. The maxillary palps are usually filiform or somewhat thicker at the extremity, shorter than the head, and composed of from four to five joints. The ant-lions (*Myrmeleon*) and termites are examples of this tribe.

Planisphere. A projection of the sphere and its various circles on a plane. [PROJECTION.]

Plank (Ger. planke, Fr. planche, Gr. πλάξ). In Architecture, a board more than nine inches in width.

Planking or Skin of a Ship. The covering of thick plank bolted longitudinally on the ribs and floor-timbers. A similar planking is fastened within. Each line of planking is denominated a *strake*; and different parts of the bottom and sides bear different names, as *black-strakes*, *wales*, *thickstuff*, *bottom-plank*, &c.

Plano-concave. In Optics, a lens which is plane on one side and concave on the other. *Plano-convex* is a lens plane on one side and convex on the other. [LENS.]

Planorbis (Lat. planus, and orbis, *an orb*). A genus of marsh snails, so called from the form of the shell, which is that of a flattened orb, arising from the volutions being coiled on the same plane. Many species of this genus are common in Britain.

Plant (Lat. planta). In Natural History, one of the objects of which the vegetable kingdom is composed. [BOTANY.]

Plantagenet. The surname of the kings of England from Henry II. to Richard III. inclusive. The name is derived from their device of a sprig of broom, or *plante de genêt*, the story of its origin being that the earl of Anjou, the first of the race, made a pilgrimage to Rome, where he was scourged with broom-twigs, and assumed the name of *Plantagenista* (literally, a *broom-twig*), which his descendants retained.

Plantago (Lat.). A genus of dwarf herbaceous plants representing the order *Planta-*

ginaceæ, several species of which are native weeds; the fruit spikes of one of these, *P. major*, are much sought after by bird fanciers as food for small cage-birds.

Plantain (Lat. plantago, plantaginis). This name, which is the common designation of the species of *Plantago*, is also applied to the *Musa paradisiaca* and *sapientum*, important tropical fruits, also called Bananas, which are little different from each other, and have been cultivated from the most remote times in warm climates (e. g. subtropical Asia, America, Africa, and the islands of the Atlantic and Pacific Oceans), for the sake of their fruits, which they produce in enormous quantities, with very little attention. There are several varieties, all more or less mawkish and viscid in the ripe state, for the starch that abounds in the unripe fruit becomes converted, as it ripens, into mucilage and sugar. They are, however, highly nutritious, and serve as the staple food of a large number of the human race. Though less nutritious than wheat or potatoes, yet the space occupied by their culture, and the care required, are so very much less, that Humboldt has calculated the produce of these plants compared to that of wheat as 133 to 1, and to that of potatoes as 44 to 1.

The specific name, *paradisiaca*, was given under the supposition that the fruits of the Plantain were the Forbidden Fruit of the book of Genesis (ii. 17). When Plantain stems are cut down or decay after the formation of the fruit, new suckers are sent up from below, which in the course of a few months produce fruit in their turn. Each bunch of fruit weighs from sixty to eighty pounds, and upwards. The abundance and nutritive properties of the fruit are not the only qualities which give these plants their value. Their leaves serve as thatch for houses, and for other domestic purposes; and some parts are used medicinally in cases of dropsy, and as an external application to burns and ulcers.

Plantain meal is obtained by powdering the dried fruit; it is very nutritious, as it contains not only starch, but protein or flesh-forming material. The fruits of the Plantain are stated by chemists to be most nearly allied in composition and nutritive value to the potato, and the Plantain meal to rice. The natives of many parts of India live almost entirely on Plantains or Bananas, and the stems, laden with fruit, are exhibited at wedding festivities, as symbols of plenty. The expressed juice is in some countries made into a fermented liquor, and the young shoots are eaten as a vegetable. [MUSACEÆ.]

Plantation. A piece of ground planted with trees, for the purpose of producing timber or coppice wood. In new countries not generally cultivated, and more especially in warm climates, the term *plantation* is applied to land employed in the culture of the more important crops; such as the sugar-cane, coffee, pepper, cotton, &c. In Britain it is exclusively applied to lands planted with trees or shrubs.

Plantigrades (Lat. planta, *the sole of the foot*; gradior, *I march*). The name of a tribe of Carnivorous Mammals, comprehending those which apply the whole or a great part of the sole to the ground in progressive motion.

Planting. The art of forming plantations of trees; also the art of inserting plants in the soil by the spade, dibble, trowel, or by other means in use in agriculture and gardening. [ARBORICULTURE.]

Plashing (Fr. plisser, *to plait*). A mode of repairing or modifying a hedge by bending down a portion of the shoots, cutting them half through near the ground, to render them more pliable, and twisting them among the upright stems, so as to render the whole effective as a fence, and at the same time preserve all the branches alive. For this purpose the branches to be plashed, or bent down, must not be cut more than half through, in order that a sufficient portion of sap may rise up from the root to keep alive the upper part of the branches. Where hedges are properly formed and kept, they can very seldom require to be plashed; but this mode of treating a hedge is most valuable in the case of hedges abounding with hedgerow trees, when from neglect, or from any other cause, the hedge has become of irregular growth.

Plasma (Gr.). The fluid of the blood in which are suspended the red particles, to which its colour is due; it consists of serum, holding fibrin in solution. It is sometimes called *liquor sanguinis*.

PLASMA (Gr. *an image*). In Mineralogy, a slightly translucent kind of Chalcedony, used by the ancients as a gem for engraving upon. It is of a grass-green or leek-green colour, sprinkled with yellow and whitish specks, and possesses a glistening or waxy lustre. It is found among the ruins of Rome, and is also procured in India and China, on Olympus, at Schwarzwald near Baden, and Hauskopf near Oppenau.

Plaster. In Pharmacy, a compound, generally of oxide of lead and olive oil, for external application.

Plaster of Paris. *Gypsum*, or sulphate of lime, commonly termed PLASTER STONE, and found abundantly near Paris, and in this country at Chellarton in Derbyshire, and Newark in Nottinghamshire.

Plasters (Gr. ἔμπλαστρον, Ger. pflaster, Fr. plâtre). Cements manufactured of gypsum or sulphate of lime. When heated to about 300°, they lose about twenty per cent. of water and fall into a white powder [PLASTER OF PARIS], which made into a thin paste with water soon solidifies, and is largely used for taking casts from busts, figures, and other ornaments; it is also the basis of *stucco* and *scagliola* or artificial marble. Combined with alum during the process of calcination, *Keene's cement* is obtained. This material dries more slowly than common plaster, but is much harder, of a less opaque white, and is more durable. Reburnt with borax and other substances, still harder and finer cements are made.

———s (Gr. πλαστική, sc. τέχνη, from πλάσσω, *I form*). In Sculpture, that which can be modelled, as clay, &c.

Plastic Clay. A clay capable of being used in the manufacture of bricks or pottery of a coarse kind. *Plastic clay* is also the name technically given by geologists to the middle group of the lowest division of the tertiary rocks in England, well developed near London, and immediately underlying the beds called *London clay*. There are corresponding beds in Paris known by the same name (*Argile plastique*).

In the neighbourhood of London, at Woolwich, the beds called *Woolwich beds* include the plastic clay, and some mottled clays, sands, and pebbles. Generally the London clay has entirely masked the true condition of the rock, but it here escapes from its trammels, and approaches the surface in a distinct and characteristic form.

Plastron. The plate forming the under side of the shell of Chelonian reptiles is so called.

Platanist (Lat. platanista). A name applied by Pliny to a fish in the river Ganges, having a snout and a tail like a dolphin, but much larger. In modern Zoology, it is the generic appellation of the Gangetic dolphin (*Platanista gangetica*).

Platanus (Lat.; Gr. πλάτανος). The only genus of the order *Platanaceæ*, a group now referred, on account of its simple carpel, rather to the Urtical than to the Amental alliance, in which it formerly stood. The species of *Platanus*, known as Plane-trees, are lofty trees with massive trunks, from which the bark annually scales off, leaving a smooth surface.

The Oriental Plane-tree, *P. orientalis*, so common in the parks and plantations of this country, grows from seventy to ninety feet high, and forms, when standing separately, a majestic object. The wood is used in the Levant and in Asia, in carpentry, joinery, and cabinet-making, and is said to make beautiful furniture on account of the smoothness of its grain, and its susceptibility of receiving a high polish. *P. acerifolia*, the tree commonly grown as *P. occidentalis*, is as large and magnificent as the Oriental Plane, the trunk having been known to attain a diameter of more than thirteen feet. The wood in seasoning becomes of a dull red colour, and although used in carpentry, it is not much esteemed. *P. racemosa*, the Californian Plane, has a wood preferable to that of *P. occidentalis*, as it is much harder and more durable, as well as less liable to warp.

Platband (Fr. plate bande). In Architecture, a square moulding projecting less than its height or breadth. The fillets between the flutes of a column are sometimes called, improperly, by this name, which is also sometimes used to denote the lintel of a door.

Plate (Ger. platte, Gr. πλατύς). In Architecture, a piece of timber lying horizontally on a wall for the purpose of receiving the ends of girders, joists, rafters, &c.

Plate. The name usually given to gold and silver wrought into articles of household furniture. For the regulations under which the manufacture of plate is carried on, see the *Com. Dict.*

Plate Glass. [Glass.]

Plateaux. In Physical Geography. [Table Lands.]

Platen. In Printing. [Press.]

Platform (Fr. plateforme, Ital. piatta forma). In Architecture, a plane surface, lying level, of any materials, for the reception of the foundations of a building, or for the piers of a bridge; also a level scaffolding raised above the ground for a temporary purpose.

Platform. In Artillery, the floor on which a piece of ordnance is placed. Platforms should be level transversely, and have a gentle incline from the rear to the front, to check recoil, and to facilitate the running up of guns.

Platform Waggon. In Artillery, a carriage on four wheels, fitted for the transport of guns, mortars, traversing platforms, or other heavy stores.

Plating. The art of covering copper and other metals with silver or gold: it is effected in various ways. Sometimes the silver is attached to and rolled out with the copper by pressure; sometimes the one metal is precipitated from its solutions upon the other; and manufacturers have lately availed themselves of electro-chemical decomposition for the purpose. [Voltatype.]

Platiniridium. An alloy of platinum and iridium found with platinum in small silver-white rounded grains in the Ural, Brazil, &c.

Platinum (Span. platina). A metal of a white colour, exceedingly ductile, malleable, and difficult of fusion. It is one of the heaviest substances known, its specific gravity being 21·5. It undergoes no change from air or moisture, and is not attacked by any of the pure acids; it is dissolved by chlorine and nitromuriatic acid, and is oxidised at high temperatures by pure potassa and lithia. It is found chiefly in South America and in the Uralian Mountains, usually in small grains of a metallic lustre, associated or combined with palladium, rhodium, iridium, osmium, and ruthenium, and with copper, iron, lead, titanium, chromium, gold and silver; it is also commonly mixed with alluvial sand. The particles are seldom so large as a small pea, but sometimes lumps have been found varying from the size of a hazel nut to that of a pigeon's egg. In 1826, it was first discovered in a *vein* associated with gold by Boussingault, in the province of Antioquia, in South America. When a perfectly clean surface of platinum is presented to a mixture of hydrogen and oxygen gas, it has the extraordinary property of causing them to combine so as to form water, and often with such rapidity as to render the metal red hot: *spongy platinum*, as

it is usually called, obtained by heating the ammonio-chloride of platinum, is most effective in producing this extraordinary result; and a jet of hydrogen directed upon it may be inflamed by the metal thus ignited, a property which has been applied to the construction of convenient instruments for procuring a light. This is a good illustration of what has been termed *catalytic* action. The atomic weight of platinum is about 98·56. It is precipitated from its nitromuriatic solution by sal ammoniac, which throws it down in the form of a yellow powder, composed of bichloride of platinum and sal ammoniac. For a long time bars of platinum were only obtained by a process suggested by Dr. Wollaston, in which the spongy platinum was compressed and the grains made to adhere by welding at a white heat. It has lately been made by intensely heating the fusible alloy of lead and platinum in a chalk-lime furnace by the oxy-hydrogen or oxy-coal-gas flame. The impurities are thus driven off, and the fused platinum is then cast into ingots. In the International Exhibition of 1862, a mass of platinum thus prepared was exhibited weighing 230 lbs., and valued at 3,840*l*.

There are some peculiarities belonging to platinum and its associates, which deserve notice, in reference to their atomic weights and their specific gravities, and which have led to their division into two groups of three each, as follows:—

	sp. gr.	atom. wt.
Platinum	21·15	98·56
Iridium	21·15	98·56
Osmium	21·40	99·41
Palladium	11·8	53·24
Rhodium	12·0	52·16
Ruthenium	11·3	52·11

It will be observed that the specific gravities and atomic weights of the first group are almost identical; as also are those of the second group, the specific gravities and atomic weights of which are almost precisely one-half of those of the first group.

The resistance of platinum to heat and chemical agents renders it a valuable article in the laboratory, and utensils of it upon a large scale are employed in some manufactures, more especially in those of sulphuric acid.

Platonic Bodies. The five regular geometrical solids, so called because they were treated of or described by Plato. They are the tetrahedron, the hexahedron, the octahedron, the dodecahedron and the icosahedron. Besides these five, there can be no other solids bounded by like, equal, and regular plane figures, and whose solid angles are all equal.

Platonism. The philosophy of Plato. The leading characteristic of the mind of Plato is its comprehensiveness. This quality discovers itself equally in the form in which his philosophy is communicated, and in that philosophy itself. The form is that of the dialogue. The *Dialogues* of Plato are at once vivid representations of Athenian life and character, and constituent parts of a system of universal philosophy; the harmonious productions of a genius which combined the dramatic imagination with the scientific intellect in a degree which has never before nor since been equalled. It is in this circumstance that we must seek alike for the influence which Plato's writings have exerted, and for the difficulty of rightly apprehending their meaning. What has been said of history in general may with equal truth be applied to the Platonic dialogues—that they are 'philosophy teaching by examples.' In place of a formal refutation of sophistry, we are introduced to living sophists; in the room of an elaborate system of philosophy, we meet the greatest philosophers of his day, reasoning and conversing with disciples eager in the pursuit of knowledge—with Athenians full of natural prejudices, with men abounding with individual peculiarities. In some of these the refutation of false philosophy, in others the establishment of his own, is the leading object; while others, again, seem chiefly designed as exemplifications of scientific method generally; though there are, perhaps, none which do not contribute to the gradual developement of his own system.

But it is not merely in the form in which his doctrines are clothed that we discern the comprehensiveness of Plato's genius. The same quality is, as we have said, equally apparent in the philosophy of which his dialogues are the vehicle. By referring to the articles ELEATIC, IONIC, and PYTHAGOREAN PHILOSOPHY, the reader will be able to form some conception of the systems which preceded that of Plato. In each of these some leading idea is taken up, and traced, generally to the exclusion of all others, through all its possible consequences. These three schools may, indeed, be severally taken as the representatives of the three constituent portions of universal philosophy: the Eleatics of the logical or dialectic; the Ionians of the physical; and the Pythagoreans, though in a less exclusive degree, of the ethical element. It was in Plato that these different tendencies first converged. Each, viewed by itself, was essentially partial and one-sided, and, with whatever of truth it might contain, must necessarily, by its very exclusiveness, combine much of error. Of this circumstance the sophists had taken advantage, and, by setting the doctrines of one system in contradiction to those of another, had succeeded in introducing a universal scepticism. Plato was thus led clearly to discern the necessity of laying the foundations of science deeper than they had been laid by his predecessors. The ultimate unity of all knowledge, properly so called, and the mutual dependence of all its parts on each other, is the fundamental hypothesis of his philosophy. How this first principle was to be attained, whether, indeed, it were attainable or not, could only be ascertained by a previous enquiry into the nature, not of *being*, but of *knowledge*. This is one mark which distinguishes Plato from

earlier speculators; and it is important to bear it in mind, if we would form a correct estimate of the services rendered by him to the progress of philosophy. The hint was unquestionably given by Socrates, but Plato was the only one among his immediate disciples who appears to have followed it up. He may, in truth, be styled the founder of the ancient psychology; and the dialogue entitled *Theætetus* may be considered one of the most important contributions to the most important branch of that science, the theory of perception and judgment, which antiquity affords. It is in this dialogue that the negative side of the enquiry into knowledge is contained. Knowledge, it is there shown, is not to be confounded either with the impressions on the senses, or with the judgments (δόξας) founded upon them. Sensation, by its very nature, is relative only; it is the joint effect of the conditions of our internal constitution and a motion, or change, communicated from without. Judgment, in so far as it is founded on a prior impression, can have no validity save in reference to that impression. Pure knowledge, therefore, if it exist at all, must be sought in some other direction. It is here that the celebrated doctrine of ideas finds its place. Without entering into the question more deeply than our limits allow, it is sufficiently clear that no other word, such as conception, notion, or the like, is adequate to convey all that Plato meant by an *idea*. [UNIVERSALS.] Having failed in finding alike knowledge in the senses and permanent being, its object in nature, he was driven, in order to avoid the sophistic doctrine of the relative nature of all knowledge, to seek for the true objects of reason in something distinct from the material universe. In place of the doctrine of Protagoras, 'Man is the measure of all things,' he substituted, 'God is the measure of all things;' meaning by this, as he elsewhere explains himself, that in the divine nature reason and being are one. From this original unity, which is denominated by Plato the good, or the supreme good, proceed, on the one hand, human reason; on the other, those ideas which constitute all in nature that is real; i.e. all that the reason can apprehend. We might hence be led to suppose that the modern term *law* may be correctly used in place of the Platonic *idea*. But, when we examine the matter more narrowly, we shall find an essential difference between the two words, not merely in the ontological or theological considerations just referred to, but also in the habit, which Plato inherited from his master Socrates, of referring the laws of the universe to a moral or *teleological* standard. The three great ideas of truth, beauty, and order or fitness, are the ultimate unities to which he conceives it to be the business of the reason to refer all its conceptions. These ideas are themselves included in the highest unity, or God, from whom it is that they derive their reality. But the supreme nature is to us incomprehensible; it is in the consciousness of our separation from the great source of being that philosophy takes its rise. The senses first suggest to us this want: we strive to bring their phenomena under general conceptions; and every attempt to understand the sensible is a self-recognition of the reason, and a step towards divinity. Theology is therefore the ultimate science in which all the other sciences converge: dialectics as the science of the true, ethics as the science of the morally beautiful, and physics as that which discerns the order and fitness of outward things. Such is a very imperfect sketch of the Platonic idea of science in its three constituent parts. Although the threefold division above given is nowhere expressly laid down in the written works of Plato, the fact that it is taken for granted by his immediate successors, Xenocrates and Aristotle, justifies us in supposing that it formed part of Plato's oral communications. But, besides this comprehensive view of universal science, we are indebted to Plato for many valuable discoveries, and many more most pregnant hints, in subordinate branches of enquiry. Among these may be enumerated the discussion of the theory of pleasure and pain, and their relation to desire and emotion, in the *Philebus*; of the first principles of the science of grammar in the *Cratylus* and *Sophist*; of the nature of mathematical science, and its place in general philosophy, *Rep.* vi. &c. In the *Republic*, which contains the substance of his moral doctrines, the intention of Plato manifestly was to develope the idea of perfect humanity, alike in the individual, and in what he regarded as an enlarged transcript of the individual, the state. [ETHICS; LIBERTY.] The most important contribution to the study and right understanding of the Platonic philosophy, with which modern times have furnished us, is to be found in the arrangement of his *Dialogues*, and the introduction prefixed to each, by Schleiermacher, a work which has been translated into English. (Ritter, *Gesch. der Philosophie*, b. viii.; Trendelenburg's *Ideæ Plat. ex Aristot. illust.*; G. H. Lewes, *Biographical History of Philosophy*. The best editions of Plato's works are those of Bekker and Stallbaum, 1858–60. For an account of his life, see Ast's *Leben und Schriften Platon.*)

In 1860, Dr. Whewell published *The Platonic Dialogues for English Readers*. But the great work which will now be consulted y English scholars is that of Mr. Grote, *Plato and the other Companions of Socrates*, 1865, in which the several theories respecting the purpose of the Platonic philosophy are examined to the foundation, and the critical questions connected with the authenticity of the philosopher's several works fully discussed. The practical conclusion arrived at by Mr. Grote, is that in the writings of Plato no one system is to be found to which he adhered consistently through life; the reason assigned by Mr. Grote being that Plato deliberately refused to promulgate his system. Mr G. H. Lewes (*Fortnightly Review*, Sept. 1, 1865) maintains that he never framed

one, and that the structure of the Dialogues of Search and the Dialogues of Exposition is so self-contradictory on all [illegible] its that no system of philosophy can [illegible] be detached from them. Mr. Grote in the same spirit remarks that when Plato propounds positive dogmas, 'he does not bring them face to face with objection, nor verify their authority by showing that they afford satisfactory solution of the difficulties exhibited in his negative procedure. The two currents of his speculation, the affirmative and the negative, are distinct, and independent of each other. Where the affirmative is especially present (as in *Timæus*), the negative altogether disappears. Timæus is made to proclaim the most sweeping theories, not one of which the real Sokrates would have suffered to pass without abundant cross-examination; but the Platonic Sokrates hears them with respectful silence, and commends afterwards.'

Platoon (Fr. peloton, *a ball of thread*; Piedm. platón: Wedgwood). In the Military art, this word was formerly used to signify a small square body of musketeers, drawn out from the main body to strengthen the angle of a larger square, or to do duty in ambuscades or defiles, &c., when there was not room for whole regiments or battalions to act.

The word is now never used, except to denote a number of recruits assembled for instruction; and in the expression *platoon exercise*, which means the exercise for loading and firing, as distinguished from the *manual* exercise, or drill for carrying the rifle or carbine in various positions.

Plattnerite. A binoxide of lead from Leadhills in Lanarkshire, where it occurs in iron-black hexagonal crystals, with the edges truncated. Named after Plattner.

Platyrrhines (Gr. πλατύῤῥις, *broad-nosed*). The name of a section of the Linnæan genus *Simia*, including those species which have the nostrils separated by a wide interspace. These monkeys are peculiar to the New World.

Platysomes (Gr. πλατύς, and σῶμα, *body*). The name of a family of Coleopterous insects comprehending species with a wide and much depressed body. These insects are found under the bark of trees, and form the genus *Cucujus* of Fabricius, now subdivided.

Pleading (Fr. plaid). Pleadings, in English Law, are the preparatory allegations in writing which intervene between the commencement of a cause and its trial.

The first object in deciding a dispute between two litigant parties is always to ascertain the subject for decision. This must be accomplished by disengaging the point in debate from all the extraneous matter in which the complaints and answers of the respective parties have involved it. This is the principle from which all the subtleties of the system of pleading, commonly called *special pleading*, are derived; and, in so far as it has departed from this object, it has wandered from its original purpose.

Pleadings were conducted orally in the first times of our jurisprudence; the parties, or their advocates, exposing the state of facts on which they relied successively before the judge, who moderated between them, and answering each other until the judge was able to fix upon the point at issue, as it was called; i.e. the question, whether of fact or law, on which the judge, or the jury, was eventually to decide. Hence issues are said to be *in fact* or *in law*. The same principle governs the course of *written pleadings* now adopted.

The plaintiff, or complaining party, having summoned the defendant into court by a writ of summons, makes his statement of the nature of his complaint, which is termed a *declaration*. The defendant may now answer him, either by denying that there is any ground in law for the action, because there is defect *in substance* in the plaintiff's alleged right, or defect *in form* in his proceedings; or by controverting the facts which he alleges, or alleging new facts in answer to them. In the former case the defendant *demurs* to the declaration; in the latter case he answers by one or more *pleas*.

A demurrer may take place either at this or at any subsequent stage of the proceedings; and may be made either by plaintiff or defendant. If the demurrer comes to be argued (which is done in term time, or in bench, before the judges of the court in which the action is brought), the court will examine the whole pleadings on both sides; and their decision on the point of law is final as to the action.

The defendant may answer or *traverse* the facts, (1) by pleading what is termed *the general issue*; a form which, in its original signification, implied an absolute denial of the facts on which the plaintiff founded his complaint; although by the refinements introduced into pleading, the general issue was formerly admitted, in each of the several *forms of action*, not only to deny the plaintiff's facts, but to allow the defendant to bring forward other facts in answer. These, however more properly form the subject (2) of *special pleas*, and are now submitted in that manner. When the defendant admits all or a part of the plaintiff's facts, but relies on certain other facts as exonerating him from the liability asserted by the plaintiff, he ought to state these facts in answer; for instance, in order to answer the claim of a debt, that it is barred by length of time, or that the defendant has a set-off to allege against it: this is termed a plea by way of confession and avoidance. To this the plaintiff may reply in his second statement, called a *replication*, either by denying the defendant's facts, i.e. a replication *by way of traverse*, or by alleging fresh ones; the defendant may deny these, or again allege fresh ones, in his *rejoinder*; sometimes a *surrejoinder*, a *rebutter*, and a *surrebutter* may be added; and the edifice of pleading is raised by stories gradually narrowing, by the exclusion of superfluous facts, until it reaches its summit in the production of one or more definite issues, either in law or fact, the decision of which finally arranges the dispute.

Thus, in an action of debt, the defendant pleads *specially* the statute of limitations, i.e. that more than six years have passed since the cause of action accrued; the plaintiff replies, admitting the length of time, but alleging that the defendant has since promised to pay the debt; this the defendant denies in his rejoinder; and hereupon, i.e. on the fact of the promise, issue is joined.

A plaintiff complains of breach of covenant by his lessee, in not repairing premises. The defendant pleads, admitting the lease and the want of repair; but alleges that he had received from the plaintiff a release from all his liability. The plaintiff replies, admitting the release, but asserting that it was obtained from him by force or duress. The defendant may perhaps deny the legal sufficiency of this ground, or *demur to the replication*; or he may traverse it in his rejoinder, denying the force or duress. In the former case, an issue of law is raised for the court; in the latter, an issue of fact for the jury.

The attorneys for the parties deliver in their respective pleadings on paper to the officers of the court. When issue is joined, these pleadings are entered on a parchment roll, on which the issue is likewise entered. This roll is called the record, and is preserved as an authentic memorial of the proceedings in the case; the verdict, and the judgment, being entered on it.

The system of pleading at law gradually attained a highly artificial state, and its strictness and subtlety were not unfrequently the cause of great delay and expense to litigants, who found their causes determined rather on a technical point of pleading than on the substantial merits of the case. An extensive reform of the whole system was accordingly introduced in 1852 by the Common Law Procedure Act of that year, which, without interfering with the general principles of pleadings, has greatly simplified and improved the details of practice.

Pleading in Equity.—The system of pleading in equity differs materially from that adopted at law. In a suit in equity, all persons having any interest whatever in the subject-matter of the proceeding, must be in some way represented in it, and the court takes possession as it were of the whole matter, directs accounts or enquiries when necessary, and decides upon the rights of the different parties. Suits in equity are, therefore, for the most part of a more complicated nature than actions at law, and less capable of being reduced to an affirmance by the one party and a denial by the other of a particular fact, on which an issue can be joined, and which, when decided, terminates the proceedings. The plaintiff in equity commences by filing a *bill*, which still retains the suppliant form of an application to the lord chancellor for his intervention to prevent or remedy injustice. The bill contains a concise statement of the plaintiff's case, followed by a prayer for the relief to which he deems himself entitled, as for an injunction agains the infringement of a patent, for the administration of a testator's estate, for a declaration of the rights of the parties entitled to trust property, or the like. The plaintiff has the power of interrogating the defendant minutely with respect to the facts stated in the bill, for the purpose of obtaining *discovery* or admissions with respect to them; and the defendant, whether so interrogated or not, is at liberty to file *answers* to the bill for the purpose of stating his own view of the case. Both bill and answers are printed, and *printed* copies are deposited among the records of the court. In the regular course the plaintiff now files a *replication* to the answers, which puts the parties at issue, and they then proceed to adduce proofs of the facts when necessary, and the cause is set down for hearing and a decree made, either interlocutory or final as the case may be. At the present time, however, it is usual for the plaintiff, instead of *filing replication*, to *move for a decree*, by which means the cause is brought on in a more summary way. A defendant, instead of answering the plaintiff's bill, may *demur* or *plead* to it under similar circumstances to those above referred to in which such defences are admitted at law. Demurrers in equity are not unfrequent, and often furnish a ready mode of deciding the point at issue between the parties. Pleas are less common, and are discountenanced by the courts, who usually consider the plaintiff to be entitled to discovery by obtaining an answer from the defendant, unless some valid objection appears upon the face of the bill and is taken by demurrer. The system of pleading in equity, though generally free from the subtlety and technicality which formerly prevailed at law, became by degrees subject to prolixity and other faults involving delay and expense, and an efficient reform was introduced in the year 1852 by the stat. 15 & 16 Vict. c. 86, and the general orders made under that Act.

Both at law and in equity the parties may now state a *special case* for the opinion of the court upon any matter of law without the delay and expense of a regular action or suit, and at law a question of fact may in like manner be stated for the opinion of a jury, but without pleadings.

Pleasure Ground. That portion of ground, adjoining a dwelling in the country, which is exclusively devoted to ornamental purposes. In the ancient style of gardening, the pleasure ground was laid out in straight walks and regular or symmetrical forms, commonly borrowed from architecture; but in the modern style it is laid out in winding walks, and in forms borrowed from nature. A portion of lawn or smooth grassy surface may be considered as essential to the pleasure ground under both styles.

Plebeians (Lat. plebs). The free citizens of Rome who did not come under the class of the patricians or clients. Though personally independent, they had in early times no political power, the government being entirely in the hands of the patricians, who formed the original *populus* (Gr. πόλις) or people.

The origin of the plebs is a subject of

controversy, which, from a lack of historical records, it is perhaps impossible to settle conclusively. The relation of the plebs to the CLIENTS is, especially, obscure; but if it be admitted (and the conclusion is at least doubtful) that all plebeians were originally included in the Clientela, from which some had succeeded in emancipating themselves, and that the citizens of Alba and other towns were incorporated into the plebeian ranks, then the whole body of Roman citizens consisted of two classes, both sprung, in part at least, from the same stock, but between which there was no right of intermarriage (*jus connubii*). The plebeians, thus prohibited from allying themselves with patrician families by marriage, were also debarred from the franchise (*jus suffragii*), and from filling any public offices; and in default of any defined relations with the ruling class, were entirely without legal remedies against the oppression of the patrician houses. This state of things led necessarily to a struggle between the two orders, in which the plebeians, having laid the foundation of their freedom by the establishment of the tribunate, slowly wrested from the patricians the privilege of filling the several magistracies, and overthrew the religious barriers which at the outset had placed a barrier between the two classes. The history of this struggle is given by Livy, Dionysius, and other writers; but no contemporary accounts have come down to us, nor have we any warrant for affirming that any such accounts ever existed, while the narratives which we possess contradict each other and themselves in the order of the incidents and the motives and policy of the actors. Plebeian grievances are said to be removed by enactments which are apparently not designed to relieve them; and complaints which had seemingly been forgotten are sometimes revived for no very obvious reason. So again, down to the law of Publilius Volero, assigned to the year 470 B.C., political agitation had reference to the struggles between the patricians and the plebeians, to demands for plebeian offices, or for a redistribution of lands; but at this point all these causes for excitement suddenly disappear, and in their place we have an absorbing desire for the compilation of a code of written laws. The details of the great conflict between the two orders of Roman citizens can thus be traced with no greater certainty than the other events of Roman history down to the period of the Punic war. (Sir G. C. Lewis, *Credibility of Early Roman History*.)

Plebiscitum (Lat. *a decree of the people*). In Roman History, a law enacted by the comitia of tribes on the rogation of a tribune. In after times plebiscita acquired the force of leges, which at first could only be passed with the consent of the patricians.

Plectognathes (Gr. πλεκτός, *twisted*, and γνάθος, *a jaw*). The name of an order of fishes, including those which have the maxillary bones anchylosed to the sides of the premaxillaries, which alone form the jaws.

Plectropoma (Gr. πλῆκτρον, *a goad*, and πῶμα, *a lid*). A name applied by Cuvier to a genus of Percoid fishes, characterised by having the angle of the preoperculum produced, or divided into a series of spines, like those which arm the rowel of a spur. All the species are exotic, and belong to warm climates.

Plectrum (Gr. πλῆκτρον; from πλήσσω, *I strike*). The small ivory instrument with which the ancients struck the lyre.

Pledge (Fr. pleige, Ger. pflicht: Wedgwood). In Law, anything pawned or deposited by way of security.

Pleiades (Gr. Πλειάδες). In Greek Mythology, seven sisters who are spoken of as daughters of Atlas and Pleione or Æthra; of Erechtheus; of Cadmus; and of the queen of the Amazons. Of these sisters, six are described as visible, the causes for the disappearance of the seventh being variously given. When the Pleiades slew themselves for grief at the loss of their sisters the HYADES, they were transformed into a cluster of stars at the back of Taurus. According to another version, they were companions of Artemis, sister of Phœbus Apollo; being pursued by the hunter Orion, they besought the interference of Zeus, who changed them into doves (πελειάδες).

Pleistocene (a word coined from Gr. πλεῖστος, *most*, and καινός, *new*). A term in Geology somewhat recently introduced, intended to include many of the newest tertiary deposits. The varieties of drift deposit, the cavern deposits, and certain beds near the mouths of rivers in England, have been included as Pleistocene deposits.

Plenarty (Lat. plenus, *full*). In Law, the state of a benefice, office, &c., when full: in opposition to vacancy.

Plene Administravit (Lat.). In Law, a plea pleaded by an executor or administrator to an action on a liability of the deceased, that he has *fully administered* his goods.

Plenicorns (Lat. plenus, *full*, and cornu, *a horn*). The name of a tribe of Ruminants, including those which have horns composed of a uniform solid osseous substance, as the antlers of deer. [CORNUA.]

Plenipotentiary. [AMBASSADOR.]

Pleonasm (Gr. πλεονασμός, *excess*). In Rhetoric, a redundant phrase or expression, sometimes introduced to give additional energy, at other times needless and ungraceful.

Pleonaste (Gr. πλεόνασιος, *abundant*). A dark or pearly-black variety of iron-and-magnesia Spinel, found at Candy in Ceylon, &c. [CANDITE.] When cut and polished, Pleonaste forms a gem of considerable brilliancy.

Plesiomorphism (Gr. πλήσιος, *near*, and μορφή, *form*). A term applied to crystallised substances the forms of which closely resemble each other, but are not absolutely identical. The primary form of sulphate of strontia is a rhombic prism very similar to that of sulphate of baryta; but on measuring the inclination of corresponding sides on each prism, the difference

exceeds 2°. Similar differences are observable in the rhombohedrons of carbonate of lime and carbonate of iron. Such substances, therefore, are *plesiomorphous*.

Plesiosaurus (Gr. πλήσιος, and σαῦρος, *a lizard*). The name of a genus of extinct marine saurians, remarkable chiefly for their length of neck. The head is small, but like that of a crocodile; the vertebræ are articulated generally by nearly plane surfaces; the cervical vertebræ have an articular surface, divided by a longitudinal impression, for a rudimental rib on each side, and two vascular foramina beneath. The digital bones of both the hind and fore extremities are flattened, and are enveloped in a sheath of skin like the paddles of the *Cetacea*. The remains of the *Plesiosauri* occur in the formations from the MUSCHELKALK to the chalk inclusive; but are most common in the lias and Kimeridge clay beds.

Plethora (Gr. πληθώρη, from πλήθω, *I am full*). A redundant fullness of the blood-vessels. It results from various causes, generally referred to *sanguine plethora*, to which the robust and athletic are most subject; and to *serous plethora*, which attacks debilitated constitutions.

Plethron (Gr. πλέθρον). In the *Iliad* and *Odyssey*, the plethron is a measure of surface. As such it was the fundamental land measure in the Greek system, being the square of 100 feet. But like other land measures, it came to be used also as a measure of length; and was in this sense equal to about 101 English feet.

Pleura (Gr.). The membrane which covers the inner surface of the thorax and its viscera. It forms two distinct portions, or bags, which, being applied laterally to each other, form the partitions called the *mediastina*.

Pleurapophysis (Gr. πλευρόν, *a rib*, and ἀπόφυσις, *process*). A pair of bones which form autogenous elements of the hæmal arch of the typical vertebra. In the thoracic segments of many vertebrates, they form the *costal* appendages or *ribs*.

Pleurenchyma (Gr. πλευρά, *a rib*, and ἔγχυμος, *juicy*). In Vegetable Physiology, the woody tissue, consisting of tough slender tubes, out of which the woody parts are mainly formed.

Pleuritis (Gr.). *Pleurisy*. Inflammation of the pleura. This disease begins with fever, cough, pain in the side, a peculiar hard and strong pulse: the symptoms often run on with great rapidity, attended by very painful respiration and other alarming symptoms. The treatment must be prompt and decided: it consists in bleeding, blisters, and the administration of calomel and opium at frequent intervals. Pleurisy is often associated with pneumonia or inflammation of the lung tissues.

Pleuroclase. [WAGNERITE.]

Pleuronectidæ (Gr. πλευρά, *a side*, and νήκτης, *a swimmer*). The name of a family of Jugular fishes which swim on their side, and of which the genus *Pleuronectes*, or sole, is the type; they are commonly called *flat-fishes*.

Plexus (Lat.). The system of equations required for the complete expression of the relations which exist between a set of quantities. Usually the equations of the system are more numerous than the relations to be expressed.

PLEXUS. In Anatomy, this term is substantively applied to those portions of nerves which interweave and interchange fasciculi, appearing to anastomose with each other, as e.g. in the arm-pit, forming the *axillary* or *branchial plexus*, and in the loins, forming the *lumbar plexus*. As nerves approach their final distribution in the several tissues, the minute fibres commonly form delicate reticulations called the *terminal plexuses*.

Plica (Lat. plico, *I fold*). A disease said to be peculiar to Poland, Lithuania, and Tartary, in which the hair becomes matted and inextricably entangled. It is often called *Plica Polonica*.

Plicidentine (Lat. plico, and dens, *a tooth*). That modification of dentine in which the substance is folded, as it were, on a series of vertical vascular plates, which radiate from the central axis of the pulp, and which is accompanied by a fluted character of the exterior of the tooth: the basal part of the teeth of the WOLF-FISH, of the *Lepidosteus oxyurus*, and of the *Ichthyosaurus*, affords examples of plicidentine.

Plicipennates (Lat. plico, and penna, *a feather*). The name of a tribe of Neuropterous insects, comprehending those which have the inferior wings wider than the others, and folded longitudinally. The mandibles are wanting in this tribe, which is represented by the genus *Phryganea*, or caddice-flies. [CADDICE WORMS.]

Plinian. A variety of Mispickel found in crystals at St. Gotthard, &c.

Plinth (Gr. πλίνθος, *a brick*). In Architecture, the lowest member of the base of a column, bearing, as its name implies, the form of a square brick or tile. [BASE.] Sometimes the abacus of the Tuscan capital is called the plinth of the capital.

Plinthite (Gr. πλίνθος, from its brick-red colour). A compact and earthy hydrated silicate of iron, found in Ireland at Down Hill, county Antrim, and Little Deer Park near Glenarm, in reddish trap-rock.

Pliocene. This name is coined from Gr. πλείων, *more*, and καινός, *new*, and was intended to mean that among the fossil remains of rocks so called more than half were identical with known living species. Rocks of the newer tertiary period were thus named by Sir C. Lyell, and the name has been preserved. As marking a group, the name is sufficiently useful; but the exact meaning originally intended is now of secondary importance.

The pliocene rocks of England are varied and tolerably extensive. They include the red crag and coralline crag of the eastern counties. The corresponding rocks on the south flanks of the Alps are on a large scale, the sub-Apennine deposits being included amongst them. Much of the brown coal of Western

Germany is also of this period, and Sicily, Greece, and Asia Minor all contain contemporaneous rocks of very large extent. Still further to the east, in the Aralo-Caspian plain they are continued. They are also found in India.

Many parts of the pliocene series are locally rich in fossils of all kinds. None are more remarkable than the great accumulations in the Aralo-Caspian plains and the Crimea. The various subdivisions and local representative rocks will be found described under special headings.

Pliolophus. A genus of Perissodactyle Mammalia from the middle eocene, or London clay. In this genus the typical dentition of forty-four teeth was maintained, in common with thirty-eight other genera, from the earlier tertiary age. The ungulate and herbivorous character of the genus is marked by the modifications of the lower jaw, especially by the relative dimensions of those parts of the *ramus* to which the temporal, masseter, and pterygoid muscles are attached. As the form of the head, however, bore some remote analogy to that of the *Carnivora*, the name of *vulpiceps* (fox-headed) has been given to the only known species.

Pliopithecus. A genus of fossil Gibbous or long-armed apes, which has been discovered in miocene deposits in the South of France. Its affinities were with *Dryopithecus* and the *Hylobates* of India.

Pliosaurus. A genus of fossil Sauropterygian *Reptilia*, allied to *Plesiosaurus*, but differing from that genus in the shorter and more powerful neck, the more massive proportions of the jaws and paddlebones. The limbs were proportionately much shorter than in *Plesiosaurus*. The genus is peculiar to the Kimeridge and Oxford clays.

Plombierite. A hydrated silicate of lime deposited from the thermal waters of Plombières.

Plongée (Fr.). In Fortification, the dip or declension of the superior slope of the parapet.

Plotting. In Surveying, this word signifies the describing or laying down on paper the several angles and lines of a tract of land which has been surveyed and measured. It is usually performed by means of a PROTRACTOR, but sometimes by the *plotting scale*.

Plotting Scale. A mathematical instrument used in *plotting*, or setting off the lengths of lines in surveying. It consists of two graduated ivory scales, one of which is perforated nearly its whole length by a dovetail-shaped groove, for the reception of a sliding piece to which the second scale is attached, and with which it moves, the edge of the second being always at right angles to the edge of the first.

By this means the rectangular co-ordinates of a point are measured at once on the scales; or the position of the point laid down on the plan. The same object is more conveniently attained by means of a graduated *offset scale*, which slides along a similarly graduated fixed scale, to which it always remains perpendicular.

Plotus (Gr. πλωτός, *floating*). A genus of web-footed birds of the family PELECANIDÆ, and nearly allied to the cormorants. They are generally known by the name of *Anhinga*, or *darters*, from the rapidity with which they shoot down into the water in the capture of fish. The white-billed anhinga (*Plotus melanogaster*) is the most common and best known species: it is a native of the tropical regions of both North and South America.

Plough (Ger. pflug, Dan. ploug, Dutch ploeg). An implement drawn by horses or by steam power, and guided by a driver, by which the surface of the soil is cut into longitudinal slices, and successively raised up and turned over. The object of the operation is to expose a new surface to the action of the air, and to render it fit for receiving the seed, or for harrowing, or for other operations of agriculture. Ploughs are of two kinds; those without wheels, commonly called *swing ploughs*; and those with one or more wheels, called *wheel ploughs*. The essential parts which compose both kinds of plough are: the beam, by which it is drawn; the stilts or handles, by which the ploughman guides it, being two levers connected with the beam; the coulter, fixed into the beam, by which the vertical side of the furrow-slice is cut; the share, also attached to the beam, by which the horizontal side of the slice is cut and raised; and, finally, the mould-board, by which the slice is turned over. The most improved form of the swing plough is that in general use in Scotland and the north of England, which is known as a modification of what is called Small's improved swing plough. The most improved wheel plough is virtually the same implement, with wheels attached to the beam, for the purpose of keeping the share at a uniform distance beneath the surface. The wheel plough as now manufactured by several English firms is the best form of the tool now in use. The subsoil plough, the invention of Mr. Smith, of Deanston, in Stirlingshire, is the swing plough, of a somewhat stronger construction than that in common use, but without the coulter and the mould-board. The use of this implement is to follow the common plough, and loosen the subsoil at the bottom of the furrow without raising it to the surface. Draining ploughs are of different kinds. The mole plough, instead of a share and mould-board, has a small iron cylinder attached to the lower extremity of the coulter. This cylinder, being drawn through grass land, leaves in its track a small opening, which has been compared to the underground track of a mole, and into which the water percolates from the surface and through the narrow slit formed by the upper part of the coulter, and is thus carried off to an open drain. Other kinds of draining ploughs cut out the soil, raise it to the surface, and turn it over in the manner of the common plough, thus leaving a deep furrow, which is commonly further deepened and modified by the spade, and afterwards partially

filled with stones, draining tiles, or other materials through which the water may find its way, and finally covered with the surface soil. Draining ploughs, though in theory promising a saving of manual labour, yet in practice are found inconvenient, from the number of horses required to work them. Their use is, therefore, generally confined to free, deep, loamy soils, with an even surface. The application of steam power to the draught of ploughs, has tended greatly to the economy and efficiency of tillage operations. The ploughing machine is, in this case, a framework containing three or more ploughs acting nearly abreast, but in succession to one another, so that a number of furrow slices are turned at once. The whole weight of the machine is carried on large wheels, and there is no pressure on the sole plate, and none of that consequent hardening of a subsoil floor upon which, in ordinary ploughing, the furrow slices lie. This tends to improve the drainage, tilth, and fertility of the soil. [STEAM PLOUGH.]

Ploughed Joints. In Building, this term is sometimes applied to the longitudinal edges of boards formed with a groove to receive either a tongue which is worked on the next board to it, or a *feather tongue*, as the connection between the two is called. Generally speaking, builders now-a-days insert a wrought-iron hoop in the joints of the boarding where they are anxious to resist the tendency of the boards to warp or to shrink laterally.

Ploughing. The act of turning over the soil by means of the plough. Trench ploughing is effected by the plough passing twice along the same furrow; the first time for the purpose of throwing the surface soil into the bottom of the furrow; and the second time for raising a furrow slice from under that which had been already turned over, and raising it up, thus turning it upon the first furrow slice. By means of this process the surface soil is entirely buried, and a stratum of subsoil laid over it; thus effecting in the field what trenching with the spade does in the garden. Trench ploughing can be employed with advantage only where the subsoil is naturally dry and of good quality, or where it has been rendered so by draining and subsoil ploughing; for bad subsoil brought to the surface would be unfit for receiving seeds or plants. [PLOUGH.]

Plough-land or **Carucate.** An ancient division of land, not, it appears, a fixed quantity, but only as much as would give employment to a plough and its team of horses during the year. The area which is implied by such a designation would, of course, vary in extent with the lightness or tenacity of the soil, and a plough-land might therefore be of any different magnitude in different manors. So a knight's fee has been variously computed at twelve or eight plough-lands. In some instances a plough-land must have contained (the soil being considerably above the average in point of fertility) upwards of a hundred statute acres. The synomyme *caruoate* is derived from the Low Latin *carruca*, a plough, still contained in the French *charrue*. In some parts of England, where oxen were more frequently used, a similar division was called an OX-GANG or *bovate*. This term is found chiefly in the northern counties.

Plover. [TRINGA.]

Plücker's Equations. [SINGULARITIES OF CURVES AND SURFACES.]

Plug (Swed. pligg, *a peg*; Dutch plug). In Architecture, a piece of wood driven horizontally into a wall, its end being then sawn off flush with the wall, in order to afford a hold to the nails that are used for fixing the dressings. In Engineering, this term is applied to the piece of wood or iron inserted into a pipe to establish a flow in the water in the particular place, as in the case of fire-plugs, the plugs that are introduced in metal boilers, &c.; these are for the most part of a lesser degree of fusibility than the pipes which they are designed to protect.

Plugs. On Shipboard, conical pieces of wood used to stop the hawse-holes, when cables are not in them; or to plug openings made by an enemy's shot.

Plum (Ger. pflaume, Dutch pruim, Lat. prunum). The common name for *Prunus*, and especially for the species called *P. domestica*, which yields the plums of our gardens and orchards. The term *plum* is also applied as an affix to the names of many kinds of fruit in various parts of the world. Thus, Hog-plum is the fruit of various species of *Spondias*; Sapodilla-plum is the fruit of *Achras*; and Sebesten-plum is the fruit of *Cordia*. [PRUNUS.]

Plumbagin. A crystallisable substance, extracted from the root of the *Plumbago europæa*.

Plumbaginaceæ (Plumbago, one of the genera). A natural order of perigynous Exogens, referred to the Cortusal alliance. The chief distinguishing features are the herbaceous stem, the stamens being placed opposite the petals, the presence of five styles, and the one-seeded membranous fruits. The order includes the familiar garden genera, *Statice*, *Armeria*, and *Plumbago*. Many of the *Plumbagos* are highly acrid and caustic. The root of *P. scandens*, the Herbe du Diable of San Domingo, is a most energetic blistering agent when fresh; so is that of *P. rosea*; while the beggars employ *P. europæa* to raise ulcers to excite pity.

Plumbago (Lat. *lead-ore*). A vulgar name for Graphite, from its leaving a mark like that produced by lead, when drawn across paper. [GRAPHITE.]

Plumbethyl. A liquid compound of two atoms of lead with four of the radical ethyl. It is violently acted on by chlorine, bromine, and iodine, but not by oxygen.

Plumbic Acid. The *peroxide of lead* = PbO_2. It is a feeble acid combining with certain bases to form compounds which have been called *plumbates*.

Plumbline, Plummet (Lat. plumbum, *lead*). A heavy body (usually a piece of lead, whence the name) suspended by a flexible thread for the purpose of indicating the perpendicular to the horizon, or the direction of terrestrial gravity. In former times the plumbline constituted an essential part of the apparatus employed for adjusting astronomical instruments; but it is seldom used in modern observations, excepting those made with the zenith sector, its place being either more conveniently supplied by the spirit level, or the method of determining the zenith point by combining direct and reflected or reversed observations. For the common artificer's plummet, see LEVEL.

Plumbo-resinite. A mineral composed of alumina and phosphate of lead, found at Huelgoet in Brittany, and Nussière in France. The name has reference to the composition of the mineral and its resemblance to gum-arabic in appearance.

Plumbocalcite (Lat. plumbum, *lead*, and calx, *lime*). A variety of Calc Spar, containing a variable quantity of carbonate of lead. It occurs in white and sometimes in pinkish rhombohedrons at Leadhills in Lanarkshire, and at High Pern Mine in Dumfriesshire.

Plumbostib. Boulangerite from Nertschinsk in Siberia.

Plumbum Corneum (Lat.). Horn lead. The old chemical name of fused chloride of lead.

Plume Nutmegs. A name sometimes given to the group called *Atherospermaceæ*.

Plummer Block. The bearing of a steam engine, or of the machinery connected with it, is known under this name, or that of pedestal, when the immediate surface of bearing is made of brass or gun metal.

PLUMMER BLOCK. In a Steamship, the part of the spring-beam of the paddle-box in which the end of the shaft is received.

Plumose Alum (Lat. pluma, *a feather*). A name formerly given to the silky amianthine crystals occasionally observed in Alum-slate. It is a sulphate of alumina and iron.

Plumose Ore of Antimony or **Plumosite** (Lat. pluma). Capillary or plumose sulphide of antimony, chiefly found in the mines of Hungary and the Harz.

Plumule (Lat. plumula, *a little feather*). In Botany, the growing point of the embryo, situated at the apex of the radicle and at the base of the cotyledons, by which it is protected when young. It is the rudiment of the future stem of a plant.

Plunging Fire. In Artillery, the fire of guns directed downwards from a height at a great angle.

Pluperfect Tense (Lat. plus quam perfectum, *more than perfect*). In Grammar, the tense which denotes that an action was finished before a certain period to which the speaker refers.

Plural. [GRAMMAR.]

Plurality. In Ecclesiastical Law, the holding of more than one benefice. It was ordained in the council of Lateran, A.D. 1215, that whosoever should take any benefice with cure of souls, if he should before have attained a like benefice, should, ipso facto, be deprived of the latter. Exceptions were made to this rule in certain cases of benefices held in commendam, by a constitution published in the council of Lyons; but it could always be evaded by dispensation from the pope. Since the Reformation, dispensations in England are granted by archbishops. Pluralities (except in certain cases of dispensation) are now limited very narrowly by the Act 1 & 2 Vict. c. 106, and 13 & 14 Vict. c. 98.

Plus (Lat. *more*). In Algebra, the additive or positive sign +, which, being placed between two quantities, signifies that they are to be taken collectively, or added together. According to Dr. Hutton, this character was first used by Stifelius, as a contraction of the letter *p*, the initial of *plus*.

Plush (Ger. plüsch). A shaggy cloth, with a velvet nap on one side. Some plushes are made of worsted, others of hair.

Plush Copper. A Cornish miner's name for CHALCOTRICHITE.

Pluto (Gr. Πλούτων). This name, denoting plenty, was originally an epithet applied to HADES, the son of Kronos, who received the empire of the regions beneath the earth, when ZEUS obtained that of Olympus, and POSEIDON became lord of the sea.

One of the playmates of PERSEPHONÊ, at the time when she was stolen by Hades from the plains of Enna, is also called Pluto (Πλουτώ). (*Hymn to Dêmêtêr*, 422.)

Plutonic. This name has been given in Geology to rocks, such as granite and certain porphyries, that are supposed to be of igneous origin, but are not volcanic. The origin of such rocks is, however, obscure, and it is doubtful how far they have really existed in a melted state. That they are due to the action of great heat, acting with water, under enormous pressure, is almost certain, but it would seem that the water was rather dissolved by the rock, than the rock by water or steam. So much is made out by the microscopic examination of thin slices, and a comparison with other rocks whose origin and history are better known.

Plutonic rocks differ essentially from volcanic: they are more crystalline, and are unaccompanied by tufa and breccias, and they exhibit few of those comparatively large pores and cavities, occupied by gas, that are common in some volcanic rocks.

Plutus (Gr. πλοῦτος, *wealth*). In the Hesiodic *Theogony* (969), Plutus is a son of Dêmêtêr and the hero Iasios, and the giver of riches and wealth to all into whose hands he comes. According to Aristophanes (*Plutus* 88), he wished to favour only the wise and righteous; but Zeus made him blind, so that he might bestow his gifts at random.

Pluviameter (Lat. pluvia, *rain*). [RAINGAUGE.]

Plymouth Brethren. This name is generally applied to the members of a body which admits the title only as describing their individual state as Christians, and which asserts that its existence is a protest against all sectarianism, their conviction being that the whole church may be united in the acceptance simply of the truths which are really vital. But while they appear to have forgotten that this very hypothesis leaves room for any amount of controversy, some of their members have laid great stress on the doctrine of a community of goods, according to the description given of the early Christian church in the Acts of the Apostles.

Pneumatic Railway. [RAILROAD.]

Pneumatics (Gr. πνευματικός, from πνεῦμα, *air* or *breath*). The science which treats of the mechanical properties of elastic fluids, and particularly of atmospheric air.

Elastic fluids are divided into two classes, gases and vapours; the former consisting of those fluids which retain their elasticity at the ordinary temperature of the atmosphere; the latter, of those which lose their elasticity, or condense like steam at common temperatures. These two classes of fluids do not differ essentially from each other, for Faraday has shown that many of the gases can be condensed by the application of great cold or pressure, and there is every reason to believe that the remainder would also be liquefied if we could expose them to still lower temperatures or greater pressures. In respect of their mechanical properties there is also no essential difference between the two classes.

Elastic fluids, in a state of equilibrium, are subject to the action of two forces; namely, gravity, and a molecular force acting from particle to particle. Gravity acts on the gases, in the same manner as on all other material substances; but the action of the molecular force is altogether different from that which takes place among the particles of solids and liquids; for, in the case of solid bodies, the molecules strongly attract each other (whence results their cohesion), and, in the case of liquids, exert an attraction of a feebler kind; but, in the case of the gases, the molecular force is repulsive, and the molecules, yielding to the action of this force, tend incessantly to recede from each other, and, in fact, do recede, until their further separation is prevented by an exterior obstacle. Thus, air confined within a close vessel exerts a constant pressure against the interior surface, which is not sensible, only because it is balanced by the equal pressure of the atmosphere on the exterior surface. This pressure exerted by the air against the sides of a vessel within which it is confined is called its *elasticity*, or *elastic force*, or *tension*.

Conditions of Equilibrium.—In order that all the parts of an elastic fluid may be in equilibrium, one condition only is necessary, namely, that the elastic force be the same at every point situated in the same horizontal plane. This condition is likewise necessary to the equilibrium of liquids, and the same circumstances give rise to it in both cases; namely, the mobility of the particles, and the action of gravity upon them. Conceive a close vessel to be filled with air, or a gas; and let a and b be two molecules situated in the same horizontal plane. It is evident that if the two molecules are in a state of equilibrium, the force with which a repels b must be exactly counteracted by that with which b repels a, for otherwise motion would take place. The same thing takes place in respect to every horizontal section of the gas; but the pressure on each section varies with its altitude. Suppose c and d to be two molecules situated in a horizontal section, *lower* than that in which are a and b. It is evident that the molecules c and d sustain a greater pressure than a and b; for, in the first place, the whole of the pressure on a and b is transmitted to them by the principle of the equality of pressure in all directions; and, in the second place, they sustain a new pressure, arising from the weight or gravity of all the molecules situated between the two horizontal planes ab and cd.

The principle which has just been explained is proved experimentally by the diminution of the pressure of the atmosphere at greater altitudes. A column of air reaching from the ground to the top of the atmosphere exerts a pressure equal to the weight of a column of mercury of the same diameter, and whose height is equal to that in the barometric tube. Now, on carrying the barometer to the top of a mountain, for example, the mercurial column is observed gradually to become shorter as we ascend; and the diminution of the column, and consequently of atmospheric pressure, is connected with the increase of altitude by a certain constant law, which enables us to deduce the one from the other, and to apply the barometer to the very important purpose of determining the relative altitudes of places on the surface of the earth. [HEIGHTS, MEASUREMENT OF.]

Boyle's Law.—In order to determine the relation between the density and pressure of the elastic fluids in the state of equilibrium, let ACB be a graduated bent tube (like a siphon barometer), having two unequal branches, of which the shorter is hermetically sealed at B, and the longer open at A. Let a small quantity of mercury be poured into the tube, just enough to fill the bend, and intercept the communication between the air in CB and the external atmosphere, and let the level EF be marked at which it stands in the two branches of the tube. It is evident that in this state the pressure of the air imprisoned between E and B is exactly equal to that of the atmosphere. Now, let mercury be poured into the tube at A; it will rise slowly in the branch EB, and much more rapidly in the open branch FA. Let mercury then be continued to be poured in until it stands at two points, D and E′, so situated that

the altitude of D above E′, or DF′, is just equal to the height of the column in the barometer, or about thirty inches. In this state, the elasticity of the air in the space E′B is in equilibrium with the pressure arising from the weight of the mercurial column F′D, and the pressure of the atmosphere exerted on D. But the weight of the mercurial column F′D is just equal to the atmospheric pressure, consequently the air in E′B is compressed by a force equal to twice the atmospheric pressure. Now, on observing the length of the column E′B, it will be found exactly one-half of EB; in other words, the air has been reduced to half its former volume. On increasing the length of the open branch of the siphon, and pouring in a proper quantity of mercury, it is found that a pressure of three atmospheres reduces the volume of air at B to one-third, and of four atmospheres to a fourth of its first volume; whence it is inferred, generally, that *the volumes of gases are inversely as the pressures which they support*. This fundamental property of elastic fluids is frequently called the *law of Mariotte*, although it was first discovered by our countryman Boyle. [MARIOTTE'S LAW.] It has been verified in several ways, on all the known gases; and, in the case of dry air, its verification has been pushed, by MM. Dulong and Arago, to pressures equivalent to twenty-seven atmospheres. (Lamé, *Cours de Physique*.) It also holds very nearly true in respect of vapours or steam subjected to a smaller degree of pressure than that which is necessary to reduce them to the liquid state. It is important, however, to observe, that in all these cases the gas or vapour must remain at a constant temperature during the experiment. The apparatus above described is called a *manometer*.

The density of bodies being inversely as their volumes, the law of Boyle may be otherwise expressed, by saying *the density of an elastic fluid is directly proportional to the pressure which it sustains*. Under the pressure of a single atmosphere, the density of air is about the 770th part of that of water; whence it follows that, under the pressure of 770 atmospheres, air is as dense as water. Thus, the average atmospheric pressure being equal to that of a column of water of about thirty-two feet in altitude, at the bottom of the sea, at a depth of 24,640 ($=770\times 32$) feet, or $4\frac{2}{3}$ miles, air would be heavier than water when the latter is under ordinary atmospheric pressure; and at the depth of about five miles would be actually heavier than the water surrounding it, so that although it would still remain in a gaseous state, it could not rise to the surface.

Effects of Heat on the Elasticity of the Gases.—The repulsive energy of the molecules of elastic fluids is greatly augmented by an increase of temperature; and it is of the utmost importance in many physical enquiries to ascertain the relation between the temperature and the elastic force. If air and most other gases, sustaining the same constant pressure, are exposed to an increase of temperature which affects all of them equally, it is proved by observation that they all undergo an almost exactly equal expansion; i.e. the increase of volume of all the gases is very nearly the same for equal augmentations of temperature, and proportional to these augmentations. Experience also shows that, within a considerable range of temperature, the indications of the air thermometer differ very little from those of the mercurial thermometer; so that, within this range, the expansion of any gas whatever is proportional to the increase of temperature indicated by the degrees of the ordinary thermometer. From the temperature of melting ice to that of boiling water, or from zero to 100° of the centigrade thermometer, Gay-Lussac found the expansion of air subjected to a constant pressure to be in the ratio of unity to 1·375, which gives an expansion of 0·00375 for each centigrade degree. Subsequent determinations made by Regnault and Magnus with more refined and delicate apparatus, prove this number to be too high. They found it to be ·003670. This being taken, let V be the volume of any gas at the zero temperature, P its elastic force, or the pressure it sustains, and D its density. Let $a=\cdot 003670$, and suppose the values of V and D to become V′ and D′ when the temperature is increased t degrees; then the pressure P being supposed constant, we have evidently

$$V' = V(1+at);$$

and the density being inversely as the volume, we have also

$$D' = \frac{D}{1+at}.$$

Now suppose the pressure to be varied without any change of the temperature, and let p denote the new pressure, and d the corresponding density; the law of Boyle gives

$$P : D' :: p : d, \text{ whence } p = \frac{Pd}{D'};$$

and on substituting for D′ its value given by the preceding formula, and making $\frac{P}{D}=k$, we obtain

$$p = kd(1+at)$$

for the expression of the elastic force of air in terms of its density and temperature.

The expansion of other non-condensable gases for the same increment of heat is nearly the same as that of air, but the coefficient for condensable gases differs more widely. The following are the values of a for the most important gases:

Hydrogen	·003661
Nitrogen	·003662
Carbonic oxide	·003669
Carbonic acid	·003710
Nitrous oxide	·003719
Sulphurous acid	·003903
Cyanogen	·003877

The coefficient k is constant for the same gas, but has a different value for different gases, depending on their densities or specific gravities. With respect to atmospheric air, its value may be found thus: The density of air, compared with water, is 0·0013, and that of mercury, compared with water, 13·59; therefore, supposing the height of the barometer to be 30 inches, the value of k, or the height of a column of air of uniform density, exerting on its base a pressure equal to that of the atmosphere, is

$$30 \text{ in.} \times \frac{13{\cdot}59}{{\cdot}0013} = 313860 \text{ in. or } 26155 \text{ feet}$$

(about five miles), the temperature being that of freezing water.

Of the Motion of the Gases.—Elastic fluids, in escaping from a vessel by a small orifice or infinitely short tube into a vacuum, observe, like liquids, a law first discovered by Torricelli; namely, that the velocity of the molecules, when they escape from the orifice, is equal to that which they would have acquired by falling through a height equal to the height of a vertical column of uniform density, producing a pressure equal to that which is exerted by the gas at the level of the orifice.

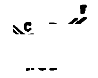
The velocities with which the different gases enter a vacuum are inversely as the square roots of their densities; for they are proportional to the square roots of the altitudes from which the molecules are supposed to fall, and these altitudes are inversely as the densities.

Thus the velocity of air rushing into a vacuum being taken as unity, Graham has experimentally demonstrated the following velocities for the gases named:

Hydrogen	3·613
Marsh gas .	1·322
Carbonic oxide	1·0123
Nitrogen .	1·0164
Oxygen .	·950
Carbonic acid	·821

[Gases, Diffusion of; Gases, Effusion of; Gases, Transpiration of.]

The principle of the lateral communication of motion holds good with respect to gases as well as liquids. On this principle we may explain a curious fact, observed in the efflux of air from a blowing machine, and in the escape of steam from the valves of boilers. If a circular disc of four or five times the diameter of the orifice be placed close to it, not only will it not be forced away by the current of the elastic fluid, but it will be retained by a considerable force; insomuch that if the orifice be directed downwards, the disc, though formed of a dense metallic substance, will be supported in opposition to its gravity. Let air issuing with considerable force through the aperture



A B have its course interrupted by the metallic plate C D; the current will assume the form of a conoid E A B F, containing the cavity E G F. At first the space C G D will be with filled the effluent air; but if a lateral communication of motion takes place, the air in this conoid will join itself to that which escapes by the edges of the plate, and a vacuum will be formed in the space C G D, and the plate C D be forced towards the aperture by the pressure of the atmosphere on the opposite side. But as it approaches the orifice the action of the effluent air will become more intense, and the dimensions of the void space be diminished, so that the plate will assume a position in which the forces tending to move it in opposite directions will be balanced.

It has been demonstrated by Newton, in the second book of the *Principia*, that the velocity with which sound is propagated through the air is the same as that which a heavy body would acquire by falling through *half* the height of the homogeneous atmosphere, and consequently equal to $8\sqrt{13078}$, or about 915 feet per second. But this theoretical determination is found to differ considerably from experiment, which gives a velocity of 1125 feet per second, when the temperature of the air is at 62°. of Fahrenheit's thermometer. Laplace suggested a very probable explanation of this discrepancy; namely, that the condensation caused by the vibrations produced a degree of sensible heat by which the elasticity of the air is increased, or, rather, the density diminished, while the elastic force remains the same. In consequence of this extrication of heat, the number given by the formula of Newton must be multiplied by the square root of the number which expresses the ratio of the specific heat of the air under a constant pressure to its specific heat under a constant volume. This number is found by experiment to be 1·375, the square root of which is 1·173; and on applying this correction with the proper corrections for temperature, the theoretical determination approaches very closely to the experimental result. [Sound.]

The science of pneumatics has been created entirely by modern discoveries. Galileo first demonstrated that air possesses weight. His pupil Torricelli invented the barometer; and Pascal, by observing the difference of the altitudes of the mercurial column at the top and the foot of the *Puy de Dôme*, proved that the suspension of the mercury is caused by the pressure of the atmosphere. Otto Guericke, a citizen of Magdeburg, invented the air-pump about the year 1654; and Boyle and Mariotte, soon afterwards, detected by its means the principal mechanical properties of atmospheric air. Analogous properties have been proved to belong to all the other gases. The problem of determining the velocity of their vibrations was solved by Newton and Euler, but more completely by Lagrange. The theoretical principles relative to the pressure and motion of elastic fluids, from which the practical formulæ are deduced, were established by Daniel Bernouilli, in his *Hydrodynamica* (1738); but have been rendered more general by Navier (*Mém. de l'Acad.* 1830). The experiments of Regnault are given in *Ann. Ch. Phys.* [3] iv. 5 and v. 52; those of Magnus in *Pogg. Ann.*

lv. 1, and lvii. 177; and Graham's researches in *Phil. Mag.* 1834, *Phil. Trans.* 1846, p. 573, and *Phil. Trans.* 1863, p. 385. [AIR; AIR PUMP; BAROMETER.]

Pneumatomachi (Gr. πνευματομάχοι). In Ecclesiastical History, a name of reproach, given to those who, in the fourth and fifth centuries, impugned the divinity of the Holy Ghost. [MACEDONIANS.]

Pneumatometer (Gr. πνεῦμα, *air*, and μέτρον, *measure*). A gasometer constructed for the purpose of measuring the quantity of air taken into the lungs, and again given out, at each inspiration and expiration.

Pneumatosis (Gr. πνευμάτωσις, *inflation*). Emphysema. A collection of air in the cellular membrane, rendering the part tumid, elastic, and crepitating when pressed. It rarely arises spontaneously, but generally from some wound which affects the lungs, and by which the air spreads through the cellular membrane. In some rare cases it is an effect of certain poisons.

Pneumobranchiates (Gr. πνεῦμα, *air*; βράγχια, *gills*). A name applied by Hunter to the Perennibranchiate reptiles of recent zoologists; and by Lamarck to an order of Gastropodous molluscs.

Pneumonia (Gr. πνευμονία). An inflammation of the lungs, or more correctly an inflammation of the true pulmonary tissue. This disease is ushered in by fever, cough, hard and rapid pulse, and if both lungs be involved severe dyspnœa occurs. The expectorated matter is coloured by blood. The tendency of pneumonic inflammation is to produce consolidation of the lung, and this, which in its first stage, goes by the name of red hepatisation, may pass on to grey hepatisation, which has been well described by Laennec. This change may again be followed by modification, degeneration, and softening, and a cavity be the result. This latter stage constitutes the pneumonic phthisis of some authors. The usual course of pneumonia, however, is that the red hepatisation becomes resolved, and the lung tissue returns to its healthy condition. Pneumonia complicates many forms of disease, viz. albuminuria. measles, typhoid and typhus fever. An interesting form of pneumonia, in which single and separate lobules are affected (lobular pneumonia), is observed in cases of blood poisoning, and other states which cause the minute ramules of the arteries of the lungs to become plugged up. Opinions vary greatly as to the proper mode of treating acute pneumonia, some recommending large bleedings and the administration of calomel, opium, and antimony, while others believe that equal success attends a less heroic and almost expectant plan of procedure. No general rule can be given, and each case would seem to demand treatment modified by a consideration of constitutional conditions, climate, &c. In pneumonia complicating other diseases the nature of the primary malady must, of course, greatly modify our views of the fittest treatment for the especial c

Pneumonology (Gr. πνευμών, *lungs*, and λόγος). The anatomy of the respiratory, vocal, and calorific organs.

Pneumothorax (Gr. πνεῦμα, and θώραξ, *chest*). An accumulation of air in the sac of the pleura.

Pnigalion (Gr. πνιγαλίων, from πνίγω, *I suffocate*). A name given by some medical authors to the *nightmare*, from the sense of suffocation which it induces. [EPHIALTES.]

Pnyx (Gr. πνύξ). The place of assembly for the Athenian demos, to the west of the Areopagus, on a slope connected with Mount Lycabettus. It was semicircular in form, and had an area of about 12,000 square yards. On the north side was the Bema, or tribune, cut out of the rock, and commanding a view of the sea from behind and of the Propylæa and Parthenon in front.

Poa (Gr. *grass*). A name given by botanists to a genus of grasses of considerable extent, and very abundant in the pasturages of Europe. One of the commonest of all weeds is the *Poa annua*. *Poa trivialis* and *pratensis* are valuable species, sown extensively as a part of the artificial pastures which are now commonly made with picked grasses instead of hay seeds. In general, they are nutritious and agreeable to cattle. *P. nemoralis* is one of the few grasses which thrive in shady places.

Poachers. [GAME LAWS.]

Poco (Ital. *little*). In Music, a word frequently prefixed to another to lessen the strength of its signification; as *poco largo*, a little slow.

Pocuamu or **Poenamu.** The name given by the natives of New Zealand to the variety of Jade or Nephrite which is used by them for the manufacture of axes and other weapons.

Pod (Mr. Wedgwood identifies this word with Dan. pude, *a pillow*; Esthon. paddi, *a cushion*: *Dictionary of English Etymology*). In Botany, the capsule of Leguminous and Cruciferous plants, the former being more particularly called legumes, and the latter siliques or silicles.

Podagra (Gr. *a seizure of the foot*). [GOUT.]

Podestà (Ital. from Lat. potestas, *power*). The chief magistrate in the republics of Italy in the middle ages was commonly so styled. His appointment was generally annual. At one time (especially at Florence) it was the custom to elect a foreigner, as more likely to be impartial. The title was retained for officers of inferior rank in Genoa and Venice. By this name were also known certain magistrates set up by Frederic I. in the Lombard cities. (Hallam's *Middle Ages*, ch. iii. part i.)

Podetia (Gr. πούς, ποδός, *a foot*). In Botany, the stalk-like elevations which support the shields of some Lichens; also the stalk of the spore-cases of mosses, &c.

Podiceps. A genus of birds, commonly called *Grebes*, placed in the order of Palmipeds by Cuvier, but forming the transition from the waders to the swimmers by having the webs of the toes incomplete, and formed by a scalloped membrane, as in the coot. The legs

are, however, placed far back, so as to render them efficient organs of swimming, while their use in walking on dry land is proportionally deteriorated; the feet are admirably organised for propelling the body through the water; and the grebe, which dives more than it swims, assists the feet with a simultaneous action of its wings; but these, like the pectoral fins of fishes, serve mainly to direct and vary the course of the bird.

Podium (Lat.). In Roman amphitheatres, a massive wall running round the arena. On the top of the podium were the seats assigned to spectators of the highest rank; above these seats rose the mœniana, or radiating seats on the sloping walls of the building.

Podophyllum (a word coined from Gr. πούς, ποδός, *a foot*, and φύλλον, *a leaf*). A small genus of *Ranunculaceæ*, found in America and India. The American species, *P. peltatum*, has lately acquired some repute as a medicinal agent, being employed as a cathartic, and as a substitute for mercury. Its large white nodding flowers are succeeded by egg-shaped yellowish fruits somewhat resembling a small lemon, and hence called Wild Lemon, though more generally known as May Apple. The herbage is narcotic and poisonous; the acid pulp of the fruit is edible though mawkish, while the rhizomes possess medicinal properties, and yield a resinous extract called *podophyllin*. The Indian species, *P. Emodi*, bears a somewhat similar fruit.

Podostemaceæ (Podostemon, one of the genera). A small unimportant order of tropical aquatics; they are of monochlamydeous structure, and are referred to Lindley's Rutal alliance of hypogynous Exogens.

Poè. The Sandwich Island name for the fermented edible corms or tubers of *Colocasia esculenta*.

Pœcile (Gr. ἡ ποικίλη, sc. στοά). A celebrated portico or colonnade at Athens, where Zeno inculcated his doctrines. The Pœcile, built by Cimon about 470 B.C., was adorned by the statues of gods and benefactors; and the picture of Polygnotus, which represented Miltiades at the head of the Athenians and Platæans at Marathon, was here suspended. The paintings, which seem to have been on wood, were removed in the reign of Arcadius, about 400 A.D. (Beulé, *L'Acropole d'Athènes*.)

Pœcilitic (Gr. ποικίλος, *variegated*). A name sometimes given to the variegated sands of the new red sandstone period, or rather to the series of rocks in which these sands occur.

Pœcilopods (Gr. ποικίλος, and πούς, *a foot*). The name of an order of Entomostracous Crustaceans, including those which have feet of different forms and uses, the anterior ones being ambulatory or prehensile, the posterior branchial and natatory.

Poenamu. [POCUAMU.]

Poetry (Gr. ποιητική τέχνη, *the art of poetry*, from ποιέω, *I make*, the writers of each different class of poems, epic, elegiac, &c., being called ἐποποιοί, ἐλεγειοποιοί, *epic-makers* and *elegy-makers*: Aristotle, *De Poet.* i. 10). A complete and satisfactory definition of poetry has not yet been produced by writers on taste, or by poets themselves. A popular one, sufficiently adapted to general notions, is furnished by Lord Jeffrey: 'The end of poetry is to please; and the name, we think, is strictly applicable to every metrical composition from which we derive pleasure without any laborious exercise of the understanding.' (*Ed. Rev.* xi. p. 216.) But, in the first place, it has been maintained that 'verse is not the limit by which poetry is bounded: it is the adjunct of poetry, but not its living principle.'—'Poetry,' says Coleridge, 'is not the proper antithesis to prose, but to science. Poetry is opposed to science, and prose to metre.'—'The proper and immediate object of science is the acquirement or communication of truth; the proper and immediate object of poetry is the communication of immediate pleasure.' In the next place, Lord Jeffrey's definition would clearly include burlesque composition. Is this strictly *poetry*? It was included, certainly, by ancient critics in their rather artificial analysis of poetry: in the *Poetics* of Aristotle the rules of comic composition are as elaborately laid down as those of any other species. Yet the excitement of the ridiculous is altogether of a different nature from that produced by poetry in the modern sense of the word, which is necessarily either elevating, imaginative, or tender. And this effect it produces, as Coleridge has described it, by communicating to the reader 'that pleasurable emotion, that peculiar state and degree of excitement, which arises in the poet himself in the act of composition.' (*Literary Remains.*) The end of poetry, then, appears to be to produce intellectual pleasure by exciting emotions either of the elevated or pathetic order. But in what mode does poetry effect this? The sight of a distressed object raises tender feelings; a tale of distress does the same: to be witness of some stupendous event, or great natural phenomenon, elevates them; and so does the description of such. Yet this tale or description is not poetry. Some dramas, almost utterly destitute of poetical merit, retain a hold on theatrical audiences merely because they are transcripts of painful scenes actually occurring in domestic life. But these are not poetry, although constantly mistaken for it. So, again, the mere narration of a grand and surprising circumstance is not poetry, however akin to poetical the emotion which it inspires. Few passages in poetry retain a greater hold on the imagination than the well-known accounts of Napoleon amidst the fires of Moscow, or the sack of Rome by Bourbon, or the execution of Charles I., or mere descriptions of the Alps or Niagara: the most prosaic writer who treats these subjects, if he only adhere to truth and bring out its striking particulars, cannot fail of producing an effect which may be termed, as regards the reader, poetical. This consideration leads us

to the great characteristic of poetry, which is essentially a creative art. Its operation is 'making,' not transcribing. 'Imitation' it is, as Aristotle defines it; not because it copies, but because it has its model in nature, and can never depart far from it without losing its character. Lord Bacon explains this by saying, that poetry 'doth raise and erect the mind, by *submitting the shows of things to the desire of the mind.*' The imagination alters these 'shows of things' by adding or subtracting qualities; and poetry brings to view the forms which result from the operation.

But Lord Jeffrey goes on, in the passage which has been already quoted, to give an analysis of the elements of poetical pleasure. 'This pleasure,' he says, 'may, in general, be analysed into three parts: that which we receive from the excitement of passion or emotion; that which is derived from the play of imagination, or the easy exercise of reason; and that which depends on the character and qualities of the diction.' The first two are the vital and primary species of poetical delight. This analysis may lead us to consider the faculties by the exercise of which these several pleasures are produced—faculties widely different, yet all poetical; some of them more and some less essential to the production of poetical pleasure; some less and some more conspicuous in different poets: all united in ly any.

1. Imagination is, emphatically, the great poetical faculty. It is 'the first moving or creative principle of the mind, which fashions out of materials previously existing new materials and original truths.' It is 'a complex power, including those faculties which are called by metaphysicians conception, abstraction, and judgment:' the first enabling us to form a notion of objects of perception and knowledge; the second 'separating the selected materials from the qualities and circumstances which are connected with them in nature;' the third selecting the materials. (Stewart: see the article 'Poetry' in the *Encyc. Brit.*) Its operations are most various, and it exhibits itself in poetry in very different degrees and forms. It may shine here and there, chiefly in comparison, or in bold and pleasing metaphor, breaking the chain of a narrative, as in the Homeric poems and the earlier poetry of most nations; it may hurry image on image, connected only by those exquisite links of thought which are present in the mind of the poet, in daring, compressed, rapid language, as if words were inadequate to its expression, as in the Hebrew prophets, in Æschylus, and often in Shakspeare; it may predominate in entire sustained conceptions, grasping at general features, as in Milton; it may cling more closely to the 'shows of things,' dwelling in particulars, reproducing with startling vividness images little altered, graphic, and minute, as in Dante; and here it often approaches to fancy. Imagination, combined in a greater or less degree with thought or reflection, but with little of the other poetical qualities, produces a kind of poetry which suits the taste of a refined and thoughtful class, but has little hold on the general mind.

2. No distinction has given critics more trouble, in the way of definition, than that between imagination and fancy. 'Fancy,' it has been said, 'is given to beguile and quicken the temporal part of our nature; imagination to incite and support the eternal.'—'The distinction between fancy and imagination,' says another, 'is simply that the former altogether changes and remodels the original idea, impregnating it with something extraneous; the latter leaves it undisturbed, but associates it with things to which in some view or other it bears a resemblance.' Now the latter is an operation of thought, wit, or judgment; and this perhaps may lead us to a right conclusion. The poetry of true fancy is merely that of imagination 'at a lower point of excitement,' or employed on less elevated subject-matter. The poetry of the *Midsummer Night's Dream*, for instance, may be termed either imaginative or fanciful with equal correctness. But there is also a spurious fancy, the offspring of a quick wit, adopting poetical diction: where wit is very nearly allied to imagination, yet not the same, as in the compositions of T. Moore.

3. Lord Jeffrey, as we have seen, associates with the pleasure of imagination the pleasure derived from 'the easy exercise of reason.' This is produced chiefly by the faculties of thought, wit, and reflection. It may indeed be doubted whether the expression of thought, however energetic and acute, clad in current poetical diction, is really poetry. Certainly it is so, if at all, in a very inferior degree to that of the imagination. And yet when we reflect how much of the pleasure which we derive from verse is of this kind, how many of the greatest names in the history of poetry are distinguished for this alone, and that one great literary nation (the French) seems to have placed its idea of poetry entirely in the expression of thought and feeling, and chiefly the former, we can scarcely refuse it an important place. It also takes many shapes. It appears in the form of witty or acute conceits, as in Donne and Cowley, and in many French and Italian poets, nearly allied to that spurious fancy of which we have spoken. It lightens in flashes of high-minded indignation or keen sarcasm in Juvenal; assumes a still loftier moral tone in Persius, and often in Dryden, mixed with grave, energetic, powerful reflection. It takes the easier tone of acute knowledge of the ways of man in the Satires of Horace, and enlivens the charming narrative of Ariosto. It often assumes a rhetorical character, as in Corneille and Lucan. There is a trivial experiment by which the difference between this and imaginative poetry may be tested. Turn both into prose: the latter retains its poetical character; the former seems to lose it.

4. The expression of passion, sentiment, or pathos, is the most common and universal of

all sources of poetical pleasure. It is the very soul of all early and simple poetry; it pervades no less that of the most civilised communities. Yet this class of poetry is less truly and emphatically poetical than the imaginative; although more popular. The pleasure occasioned by it is of a mixed nature: it arises from the excitement of peculiar sympathies, not produced, but heightened only, by the form in which that excitement is conveyed. This is the reason why mere popularity is not a test of the excellence of poetry. The uncritical reader calls that the best poetry by which he is best pleased. Devotional poetry, for instance, appeals to a universal class of sympathies; and on this account often acquires a factitious value. The highest attribute of a poet, in this branch of the poetical faculty, is a sensibility to all the springs of our passions, joined with the art of expressing it; these, when united with that power of personification which is more peculiarly the dramatic faculty, produce the drama in its highest and noblest shape, such as it is exhibited by Shakspeare, and by him alone. But the power of giving language to the sentiments of any common and elevated passion is by itself a great poetical merit. The passion of love is the staple of numberless bards. The passion for war or conflict, unhappily natural to man, is a source of poetry: it is impossible not to perceive in Homer and Scott, independently of their art of narration and energy of description, an exultation in the animal excitement of the imaginary battle, the *certaminis gaudia* of the savage Attila, peculiarly and intensely poetical. The sentiment of self-love, the natural propensity to exhibit self to self in a romantic or elevated point of view, forms a great part of the charm of such a muse as that of Byron. Again, independently of the direct expression of feeling, there is in some poets a general colouring derived from it, thrown as a light veil over all the objects presented, which is a singularly attractive attribute. Such is the tinge of grave and serious tenderness which shades the poetry of Sophocles and Virgil, and assumes, perhaps, a more feminine character in that of Tasso.

These are the more strictly subjective qualities of true poetry. There are others, of a more objective character, which can scarcely be said to belong to it strictly *as* poetry, and yet can scarcely be excluded from a general review, such as:—

5. The dramatic faculty, of which we have already spoken, which seems to consist in acute powers of observation of the varieties of human character, together with the rarer power of delineating it with such force as to bring the imaginary person distinctly before the reader. It is the wonderful and unique characteristic of Shakspeare, in whom all individuality, as has been often observed, seems absolutely lost. If we are to look for a second to Shakspeare in this high faculty, we shall find him, among poets, perhaps only in Scott. But it is a power often much developed in writers who are not poets in any sense, such as Le   and De Foe.

6. The descriptive faculty is of the same kind; that of bringing the objects of external nature, or passing scenes of whatever sort, vividly before the reader's fancy. When the objects or scenes so represented are such as the painter might choose with advantage for the exercise of his art, the faculty is properly termed *picturesque*; though that word is often of a looser acceptation. It is obvious that this also is a faculty common to poets, with many others who are not so; but sustained energy of description, as in the Homeric poems, forms a magnificent groundwork for strictly poetical ornament. In the poetry of modern times, especially in this country, and in Germany, the description of external nature has been made subservient to the purposes of imagination and reflection by writers of high genius; and this combination peculiarly characterises the taste of the age, of which Wordsworth and Tennyson, in very different manners, may be cited as illustrious examples.

7. Lord Jeffrey ranks last the pleasure derived from diction, as of a secondary order; which it undoubtedly is, and yet almost essential. The highest poetry, without beauty of style, is rarely or never popular, while the poems of Virgil owe their charm chiefly to beauty and felicity of diction.

8. Lastly, we must not omit the pleasure of *melody*: not essential to poetry, since there may be poetry without verse; not always a merit of the poet himself, since much depends on the language—and a Greek or Italian poet, cæteris paribus, will ever be preferable to an English or German one, on this account alone; but a grace which heightens the charm of the noblest poetry, and sometimes captivates the sense even in the most indifferent.

Pogostemon (Gr. *πώγων*, *a beard*, and *στήμων*, *a thread*). The genus of Labiate plants which yields the Patchouly scent. The plant itself, called *P. patchouly*, is an unattractive subshrubby species, found wild in India and Malacca. The odour, which is peculiar, is highly popular not only in Europe but in India, where it is one of the commonest perfumes found in the bazaars. The leaves and young tops yield by distillation the volatile oil from which essence of Patchouly is prepared. Genuine Indian shawls and Indian ink were formerly distinguished by their odour of Patchouly, but since the perfume has become common in Europe the test does not hold good. Ill effects, such as loss of appetite and sleep, nervous attacks, &c., have been ascribed to the excessive employment of Patchouly as a perfume. It is called ***Pucha-pat*** by the Malays. [PATCHOULY.]

Poinding. In Scottish Law, a species of diligence (i.e. process), whereby the property of the debtor's movables is transferred to the creditor. Poindings are either real or personal; the former affecting the debtor's movables on the lands to which the debt attaches, the other

his movables generally. The effect of real poinding is to give the user of it right to the rents.

Poinsettia (after M. Poinsette, its discoverer). A genus of *Euphorbiaceæ*, by some botanists included in *Euphorbia* itself, interesting chiefly for its ornamental properties. It produces at the ends of its shoots, surrounding the inconspicuous flowers, a number of large elliptic scarlet bracts, which render it exceedingly ornamental; and small plants surmounted by a coronal of these highly coloured leaves are now grown in large numbers for the flower markets, being all the more valuable from bearing their inflorescence in winter.

Point (Lat. punctum). A steel instrument used by engravers for tracing the work on a copper plate. A diamond point is sometimes used in gem-engraving.

POINT. In Geometry, that which has position but not magnitude. The extremities of a line are points. It is sometimes convenient to consider a point as an evanescent circle or sphere. A *point-circle* has thus the equation

$$x^2 + y^2 = 0,$$

and a *point-sphere* the equation

$$x^2 + y^2 + z^2 = 0.$$

POINT. In Heraldry, an ordinary somewhat resembling the pile [PILE], but issuing from the base of the escutcheon instead of the chief: seldom used in English, but frequently in foreign armories.

POINT. In Music, a character used by many instead of the dash, its chief use being to distinguish those notes from which an intermediate effect is required dissimilar to the dash.

Point Blank. In Gunnery, this term denotes the position of the gun when so pointed that its axis produced will pass through the object aimed at. A gun may therefore be point blank with reference to an object, and yet not be parallel to the horizon. The *point blank range* of a gun is the range obtained at the first graze of the shot, when the piece placed on its proper carriage is fired, with the service charge, on a horizontal plane, with no elevation.

Point of Inflexion. [INFLEXION.]

Point of Mean Impact. In Rifle practice, the point formed by the intersection of two lines drawn parallel to two fixed bases, horizontal and vertical, generally one side and the bottom of the target. From these bases the horizontal and vertical distances of each shot are measured, and the mean distances of all the shot are found by dividing the sum of the distances by the number of shot. Lines are then drawn at these mean distances, and their intersection is the *point of mean impact*, from which the distance of each shot is measured; these distances are added together, and their sum, divided by the number of shot on the target, gives the *figure of merit*. Half a diagonal of the target is allowed for every shot that misses.

Points. Small flat pieces of cordage put through the sails in horizontal rows, for the purpose of reefing them.

Points of the Compass. [COMPASS.]

Points, Conjugate. [ANHARMONIC RATIO; CONJUGATE AND ISOLATED POINTS.]

Points of the Escutcheon. In Heraldry, the nine points of the escutcheon are marked by letters in the cut attached to the article HERALDRY, which is copied from those in the ordinary English works on the elements of the science. They are: A, dexter chief; B, middle chief; C, sinister chief (Fr. chef, *head*); D, honour point; E, fess point, which is the centre of the shield (Lat. fascia, *belt* or *sash*, from the belt encircling the middle of a man); F, nombril point (navel); G, dexter base; H, middle base; and I, sinister base. It will be observed, that the greater part of these names are taken from those parts of the human body which the shield was taken figuratively to represent.

Points of Support. In Architecture, the collected areas on the plan of the piers, walls, columns, &c., upon which an edifice rests, or by which it is supported. It is evident that the smaller their total area, compared with the superficies of the whole building, all other things being equal, the greater is the skill exhibited by the architect; and this for many reasons, not the least of which is the greater economy thus attained. But it is necessary in all cases to bear in mind the resistance of the materials to a crushing weight; which circumstance has led to great modifications of late in the proportions of the points of support, owing to the introduction of metal in building operations. We subjoin a table of some few buildings in Europe, examined for the purpose of ascertaining the relative areas of their supports compared with the area covered; arranged in the direct order of the proportion of the latter.

Ratio (to 1·000) of Points of Support to Area	Edifice	Total Area in English Feet	Area of Points of Support
0·056	Temple of Claudius, in Rome, now church of S. Stefano	36,726	2,051
0·100	Church of S. Sabino, Rome (destroyed)	15,159	1,545
0·118	St. Paolo, Rome	106,515	12,655
0·127	Temple of Peace in Rome	67,125	8,571
0·129	Church of St. Filippo Neri, Naples	22,826	2,944
0·150	Church of St. Giuseppe, Palermo	26,046	3,611
0·140	Church of Notre Dame, Paris	67,543	8,784
0·146	Church of St. Dominico, Palermo	34,144	4,988
0·151	Church of St. Sulpice, Paris	60,760	9,127
0·154	Church of Ste. Geneviève, Paris	60,287	9,269
0·155	Church of St. Peter ad Vincula, Rome	21,520	5,353
0·157	Church of St. Vitale, Ravenna	7,276	1,142
0·165	Temple of Juno Lucina, Sicily	6,821	1,110
0·167	Central building of Baths of Diocletian, Rome	351,656	58,797
0·169	Cathedral of Milan	125,853	21,565
0·170	St. Paul's, London	84,025	14,311
0·172	Greek Temple of Pæstum	15,365	2,649
0·176	Central building of Baths of Caracalla, at Rome	275,503	48,911
0·194	Temple of Concord, Girgenti, Sicily	6,849	1,330
0·201	Sta. Maria dei Fiori, Florence	84,802	17,030
0·217	Mosque of Sta. Sophia, Constantinople	105,200	22,867
0 232	Pantheon, Rome	34,238	7,954
0·235	Ancient Temple, Galuzzo, Rome	9,206	2,167
0 261	St. Peter's, Rome	227,069	59,308
0·268	Hôtel des Invalides, Paris	29,003	7,790

Pointed Architecture. [ARCHITECTURE.]

Pointer Dog. The variety termed *Canis familiaris avicularius* by Linnæus. It is supposed to have been introduced from Spain. The descendants of the English variety of pointer when imported into tropical countries retain the acquired instinct of *pointing* to the same extent as their ancestors.

Pointers, The. In Astronomy, the two bright stars in the body of the Great Bear, which point to the pole star, and enable it to be readily singled out.

Pointing. In Artillery. [LAYING A GUN; GUNNERY.]

Poison (Fr.; Lat. potio, *a potion*). A poison is commonly defined to be a substance which when administered in small quantities is capable of acting deleteriously on the body, and in popular language is confined to substances which destroy life in small doses. There are many difficulties in respect to the medical and legal definition of poisons, which are discussed in works on Toxicology, more especially in reference to the strict meaning of the term *deadly poison*, which is generally used in indictments for poisoning. (Taylor *On Poisons.*) [TOXICOLOGY.]

Poison, Arrow. The name of Arrow Poison is given to various plants with which the natives in different parts of the world poison the tips of their arrows to render them more fatal in their effects. For this purpose the juice of *Euphorbia heptagona, virosa,* and *cereiformis,* is used in Africa, and that of *E. cotinifolia* in Brazil; the Wourali, Ourari, or Carana poison, derived from *Strychnos toxifera,* is employed by the savages of Guiana; and the Tieuté poison, prepared from *Strychnos Tieuté,* by the Javanese. The poisonous juice of the Manchineel, *Hippomane mancinella,* is also used for a similar purpose.

Poison Wood. The name given in America to *Rhus venenata,* a virulent species of a poisonous family.

Poison-fang. The superior maxillary teeth of certain species of serpents are so called, which, besides the cavity for the pulp, appear to be perforated by a second longitudinal canal, which is open at both ends and receives at the end nearest to the base of the fang the termination of the duct of the poison-gland.

The tooth consists essentially of a narrow and thin plate, bent upon itself lengthwise, and with the approximated margins adherent together. In some poison-fangs the line of adhesion is visible along the convex side of the tooth. There is generally but one poison-fang on each maxillary bone; but sometimes there are a few additional teeth behind the principal fang. The fang ordinarily lies recumbent; but when the serpent is about to strike with this weapon, it is erected by a rotatory movement of the jaw, and the poison-gland is at the same time compressed and emptied of its secretion, which is injected through the hollow fang into the wound.

Poison-glands. Those glands which secrete an acrid or venomous liquor, conveyed along an instrument capable of inflicting a wound, are so termed. The glands at the sides of the head of poisonous serpents, those at the base of the hollow jaws of the centipede, or at the aculeated tail of the scorpion, that communicating with the sting of the bee and with the spur of the ornithorhynchus, are examples.

Polacca (Ital.). A peculiar vessel with three masts, navigated chiefly in the Levant and other parts of the Mediterranean.

Polar. Having reference to poles; as *polar circles, polar regions, polar projection,* &c.

Polar Bear. A genus of bears, dismembered from the true bears (*Ursus*) under the title *Thalarctos maritimus.* It differs from its congeners by the extreme flatness of the forehead, as well as by the proportions of the limbs and form of the teeth. It inhabits the Arctic regions, where it devours a greater comparative amount of fish and flesh than other bears. The chase of the white or polar bear forms an important source of employment to the Esquimaux, who use it as food.

Polar Clock. An optical apparatus, invented by Professor Wheatstone, for finding the hour of the day from the polarisation of solar light.

Light reflected from the atmosphere, like other reflected light, is polarised in a certain plane; and it is found that the light reflected from any particular point of the sky is polarised in the plane passing through that point, through the sun, and the eye of the observer. Suppose the point of the sky under observation to be the pole, then the plane in question is one which passes (sensibly) through the axis of the earth's rotation, and consequently the angle which it makes with the meridian is an hour angle: if, then, the situation of this plane be determined, the hour of the day, or time from true noon, is determined also.

Mr. Wheatstone's method of determining the plane of polarisation consists in attaching to the top of an upright pillar a glass plate, held by a brass ring, and directed perpendicularly to the earth's axis, the lower half of the ring being divided into twelve equal parts (which may be again subdivided) to represent the hours. A conical tube is fitted into the brass ring, so that its axis is parallel to that of the earth. The upper and wide end of the tube is closed by a plate of glass having a star of selenite on it, and a Nicol's prism is attached to the lower end. The principal sections of the thin plates of selenite which form the star are all parallel, and inclined at an angle of 45° to the plane of polarisation of the prism, and so placed that the lamellæ simultaneously appear colourless. In order to make the observation the tube is turned till the central portion of the star exhibits the maximum of red colour, when a black line drawn on the glass plate in the direction of a principal section of the lamellæ, and serving as an index, gives the position of the plane of polarisation of the reflected light, and consequently indicates the

hour. Instead of this apparatus, Soleil proposed to use a polariscope containing two plates of quartz of opposite rotation, in which case the situation of the plane of polarisation becomes known by the equality of colour.

The polariscope has some advantages over the sun-dial, inasmuch as it may be used some time before sunrise and after sunset, and even when the sky is in some measure clouded; but the practical use of the instrument appears to be subject to many considerable difficulties. (*Annual Report on the Progress of Chemistry, &c.* vol. iii. part i.)

Polar Coordinates. [COORDINATES.]

Polar Developable of a Non-Plane Curve. The surface enveloped by its normal planes. The generators of the surface or the intersections of consecutive normal planes were called by Monge the *polar lines*; they are perpendicular to the respective osculating planes, and pass through the centres of absolute curvature. Every point of a polar line, and consequently every point of the polar developable, is obviously equidistant from three consecutive points of the curve. The intersection of two polar lines, which is a point on the cuspidal edge of the polar developable, is equidistant from four consecutive points on the curve, and consequently the centre of the osculating sphere, or sphere of closest contact with the curve. Since every normal to the curve touches the polar developable, two intersecting consecutive normals meet each other on a polar line, and the plane of the two contains the tangent to the original curve as well as the normal to the polar developable. From this it follows that the cuspidal edge of the developable formed by a series of intersecting normals of the curve is a geodesic; on the polar developable it is also an evolute of the curve, so that the polar developable may be regarded as the locus of the evolutes of the original curve. By unfolding the polar developable into a plane, the original curve, which is an orthogonal trajectory of its tangent planes, becomes, as it were, condensed into a point, and the series of evolutes becomes transformed into a pencil of rays having that point as centre. The polar developable also contains the locus of the centres of absolute curvature, but this does not in general form one of the series of evolutes, since two successive principal normals do not intersect one another, but touch the polar developable at consecutive points of the same polar line. We may mention lastly an important relation between the primitive curve, and the cuspidal edge of its polar developable, viz. the angle of contact of the one is equal to the angle of torsion of the other. A similar relation, however, does not exist between the radii of curvature and torsion, since the corresponding elementary arcs of the two curves have in general different lengths. All that can be asserted with respect to these radii is that the rectangle under the corresponding radii of curvature is equal to that under the radii of torsion. The polar developable of a spherical curve is a cone whose vertex is at the centre of the sphere with which all osculating spheres coincide. The polar developable of a plane curve is a cylinder standing on the plane evolute of that curve, and containing all its non-plane evolutes. [EVOLUTE.]

Polar Distance. The angular distance of a celestial body from either pole. Thus we have *north polar distance* and *south polar distance.* The *declination* of a celestial body is its distance from the celestial equator, and in each hemisphere is the complement of the polar distance.

Polar Lights. [AURORA BOREALIS.]

Polar Line of a Non-Plane Curve. The name given by Monge to the line in which two consecutive normal planes intersect one another. [POLAR DEVELOPABLE.]

Polar Reciprocal of a Plane Curve. The locus of the poles of its tangents, or the envelope of the polars of its points, these poles and polars having reference usually to a given *circle.* The polar reciprocal (or *reciprocal*, as it is more frequently called) and the primitive curve, therefore, are reciprocal polars with respect to an auxiliary circle. The equation of this circle being written in the homogeneous form:

$$x^2+y^2+z^2=0,$$

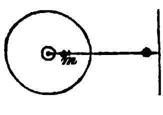
the polar of a point ξ, η, ζ, will have the equation,

$$x\,\xi+y\,\eta+z\,\zeta=0,$$

and the equation of the polar reciprocal will be simply the expression of the condition that this polar shall touch the primitive curve. The function of ξ, η, ζ, which when equated to zero expresses this condition, belongs to the class of functions called *tactinvariants*, and in this particular case the function is called the *reciprocant* of the quantic u, where $u=0$ is the equation of the primitive curve. [TACTINVARIANT and RECIPROCANT.]

The actual calculation of the reciprocant is often a difficult problem: it has, however, been effected for many curves of higher orders, as may be seen on reference to Dr. Salmon's works.

The auxiliary quadric with respect to which poles and polars are taken being a circle, metrical as well as graphic properties of curves may be easily transformed. The centre of the auxiliary circle (or *origin*) being at o, the polar of any point m, on the primitive curve u, is the perpendicular to om at the inverse point m_1, where $om.om_1=k^2=$ (radius)^2. The locus of m_1, therefore, is at once the inverse curve to the primitive and the pedal of its polar reciprocal;



in other words, the polar reciprocal is the first negative pedal of the inverse of the primitive; or, what is the same thing, the inverse of the first positive pedal. In this manner a

useful relation is established between three important classes of curves. [INVERSE CURVES and PEDALS.]

The polars of points *in lines* are obviously homographic with respect to the points themselves, and therefore correspond anharmonically to the latter; so that to a point and its polar with respect to any conic C correspond, respectively, a polar and its pole with respect to the reciprocal conic C′. The properties of reciprocal conics, however, are too numerous to be here enumerated, and are fully discussed in all good treatises on the subject.

In the same way the polar reciprocal of any surface S is the locus S′ of the poles of its tangent planes, or the envelope of the polar planes of its several points, with respect to an auxiliary sphere. The polar plane of every point m is perpendicular to the radius vector om, and cuts the latter in a point m_1, such that $om.om_1 = k^2 =$ const. The polar of every line is a line at right angles to the former, and the shortest line between the two always passes through the origin. Since a surface S of the n^{th} order meets every line in n points, n tangent planes can be drawn through every line to the reciprocal surface S′; in other words, the latter is of the n^{th} class. If one of these surfaces is a quadric, therefore, the other will be so. The reciprocal of a ruled surface is another ruled surface of the same order, for in the one, since an infinite number of tangent planes pass through a generator, in the other an infinite number of points will lie in a line, and further, the order and class of every ruled surface are equal—the planes being all tangent planes which are drawn through an arbitrary line and the n generator of the surface which it meets. The polar reciprocal of a developable is a non-plane curve, for since in the former the tangent planes coincide at all points of a generator, in the latter the points of contact of all planes through a tangent coincide. The order of the developable is again the same as the class of the curve, and the class of the developable, or number of tangent planes through a point, is equal to the order of the curve. To the cuspidal edge of the one corresponds the developable formed by the tangents of the other, and so on. Finally, the polar reciprocal of a cone is a plane curve.

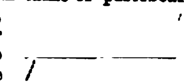
Polar Triangles. [SPHERICAL TRIGONOMETRY.]

Polars, Reciprocal. [RECIPROCAL POLARS.]

Polarisation of Light. Ordinary light is regarded as consisting of ethereal undulations occurring in every conceivable plane. By the reflection of such light from certain surfaces, or by its transmission through certain bodies, these undulations are made to take place in one or two planes only. The light is then said to be *polarised.*

The polarisation of light may be effected in various ways, but chiefly in the following: 1. By reflection at a proper angle from the surfaces of transparent media, as glass, water, &c. 2. By transmission through crystals possessing the property of double refraction. 3. By transmission through a sufficient number of transparent uncrystallised plates placed at proper angles. The following experiment will serve to illustrate the first of these modes, and also give a clear idea of the difference between common and polarised light.

Let A and B be two metallic or pasteboard tubes open at both ends, and fitting into each other so as to turn stiffly. Into each of these let a piece



of polished glass M, N, having one of its sides roughened, and blackened with melted pitch or black varnish so as to destroy its internal reflection, be fixed in such a position that its surface shall make an angle of 33° with the axis of the tubes. Let the tubes now be placed so that the light from the sun or any luminary falling on the plate M, shall be reflected along the axis: and let the tube A be fixed in that position. The light which traverses the axis of the tube will fall on the plate N, from which it will be again reflected, and may be received by the eye, or on a screen. The apparatus being thus arranged, let the tube B be turned round within A, carrying with it the reflector N, which in its revolution will always preserve the same inclination to the axis of the tube; and the ray of light reflected from N will describe a conical surface. Now, on attending to the ray reflected from N, it will be observed in the course of the revolution constantly to vary in intensity: at two opposite points it will acquire a maximum of intensity; and at other two opposite points, intermediate between these, it will entirely disappear. On comparing the positions of the reflecting planes at the occurrence of these phases, it will be found that the intensity of the light is greatest when the plane N is *parallel* to M, and that there is no reflection from N when the two planes are *at right angles.* It thus appears that a ray of light reflected from the surface of glass at this particular angle of 33° is incapable of being reflected a second time from a similar surface, perpendicular to the former, at an equal angle of incidence. This property is expressed by saying that the light reflected from M is *polarised in the plane of reflection.* It has, in fact, acquired some property or modification, in virtue of which, while it preserved the power of being again reflected in the same plane, it ceases to be subject to the ordinary law of reflection in a perpendicular plane.

When the ray reflected from M is received perpendicularly on a tourmaline plate, it will present different phenomena of transmission according to the position of the axis of the plate, i. e. the axis of the crystal from which the plate was cut. If the axis is parallel to the reflecting plane, the whole of the light will be transmitted through the plate; but if the plate be turned round in its own plane until the axis becomes perpendicular to the reflecting plane, no portion of the light will be transmitted.

From these experiments it appears that light polarised by reflection possesses the following characters, which are invariably found to belong to all polarised light, in whatever way the polarisation may have been produced: 1. It is incapable of being reflected by polished transparent bodies at certain angles of incidence, and in certain positions of the plane of incidence. 2. It is incapable of being transmitted by a plate of tourmaline when incident perpendicularly upon it, in certain positions of the plate; but it is readily transmitted by it in certain other positions, at right angles to the former.

The polarisation of light by reflection is only effected completely when the light falls on the reflecting surface at a particular angle; and it has been mentioned that, in the case of glass, the angle which the direction of the ray must make with the surface is about 33°, or the *angle of incidence* (the complement of the former) must be 57°, in round numbers. This angle is called the *polarising angle*. It is different for different substances; but from an extensive series of experiments with a great number of different bodies, Sir David Brewster found the following remarkably simple and beautiful relation to subsist in all cases between the polarising angle and the refractive power of the medium, viz. *The tangent of the polarising angle for any medium is the index of refraction belonging to that medium.*

All reflecting substances are capable of polarising light if incident at proper angles; but metallic bodies, and bodies of very high refractive power, like the diamond, appear to do so only imperfectly, the reflected ray not *entirely* disappearing in circumstances when a perfectly polarised ray would be completely extinguished.

When light is reflected at an angle greater or less than the polarising angle, it is partially polarised. A second reflection in the same plane renders the polarisation more complete; and by repeating the reflections a sufficient number of times, it may be polarised at any angle of incidence.

The second method of effecting the polarisation of light, above mentioned, is by transmission through doubly refracting crystals. When a ray of common light is separated into two by double refraction, both the pencils, at their emergence from the crystal, are found to be completely polarised; but in different planes, at right angles to each other. This may be proved by receiving them on a reflecting surface at the polarising angle, or by examining them through a plate of tourmaline, or by interposing a second crystal also having the power of double refraction; and in all cases each pencil will exhibit the same phenomena as light polarised by reflection. Let a ray of light fall on a rhomboid of Iceland spar, it will be separated into two, of which call O the ordinary ray and E the extraordinary ray. Let both pencils be received on a second rhomboid, and the following phenomena will be observed. When the rhomboids are in similar positions, or have their homologous faces parallel, neither of the pencils will be separated by the second crystal; but O will produce only an ordinary ray, and E only an extraordinary ray. On turning the second crystal round through an angle of 90°, O produces only an extraordinary ray, and E only an ordinary ray. In intermediate positions, each pencil is separated by the second crystal into two, in the same manner as ordinary light. This experiment, which was first made by Huygens, and accurately described by him, may be made as follows: Take two moderately thick rhomboids of Iceland spar, and lay them down (the one over the other) on a sheet of white paper, having a small and well-defined black spot on it. When the rhomboids are so placed that their homologous sides are parallel, the spot will be seen double through the combined crystals, as if they formed one piece; both images will be equally bright, and the line which joins them will be parallel to the principal sections of the crystals. This is shown at A in the figure below. If we now turn round the upper crystal in the horizontal plane from left to right, two new faint images will make their appearance, as at B. Continuing to turn, the four images will be all equally luminous, as at C, where the crystal has been turned 45°. As the rotation proceeds, the two original images become extremely faint, as at D. When the crystal has been turned 90°, there will again be only two images, as at E: two new faint images will again appear at F. At G, where the angle of rotation is three quadrants, the four will be again equally bright; farther on at H they will become unequal; and at I, when the revolution is precisely 180°, they will all coalesce into one bright spot. From all these appearances it follows that the ordinary ray is polarised in the principal plane of the crystal, and the extraordinary ray in a plane perpendicular to the principal plane.

A B C D E F G H I

The phenomena produced by the polarisation of light are among the most splendid and singular in the whole range of physical science. They lay open many new views of the constitution of natural bodies, and their explanation constitutes the principal part of the theory of light. The general explanation, according to the undulatory theory of LIGHT has been thus given:—

'Common light consists of undulations in which the vibrations of each particle are in the plane perpendicular to the wave's motion. The polarisation of light is the resolution of each vibration into two, one parallel to a given plane passing through the direction of the wave's motion, and the other perpendicular to that plane, which become in certain cases the origin of waves that travel in different directions. When we are able to separate one of these from the other, we say that the light of each is polarised. When the resolved vibration parallel

to the plane is preserved unaltered, and that perpendicular to the plane is diminished in a given ratio (or vice versâ), and not separated from it, we say that the light is partially polarised.' (Airy's *Mathematical Tracts*, p. 339.)

Circular Polarisation is produced when light is twice totally reflected from the second surfaces of bodies at their angle of maximum polarisation. It may also be produced, as was discovered by Arago, by the passage of light through rock crystal; or, as discovered by Biot and Seebeck, through certain fluids, as oil of turpentine, oil of laurel, solution of sugar, &c.

Elliptic Polarisation is produced by reflexion from the polished surfaces of metals at angles included between 70° 45′ and 78° 30′; gold having the least and tin the greatest polarising angles. This property was discovered by Sir David Brewster.

The polarisation of light by reflexion was accidently discovered by Malus, a French engineer officer, in the year 1810; and the phenomena, which appeared the most remarkable of any that had yet been observed, both on account of their splendour and their intimate relations with the more interesting parts of physical optics and the theory of light, soon began to be studied with great care, and to be varied in every possible way, by Malus himself, by Biot, Arago, Dr. Young, Seebeck, Sir David Brewster, Sir John Herschel, and many others. But the writer who beyond all doubt contributed most to connect them with theory, and to show their mutual relations and dependencies, was Fresnel, whose success in deriving them, by à priori reasoning, from the principles of the undulatory hypothesis of light, was so complete as to place the evidence of the truth of that theory on almost the same footing of credibility as that of gravitation itself. Analogous phenomena to those of the polarisation of light have been found to belong also to radiant heat. Dr. Forbes, Principal of the University of St. Andrew, who has been one of the most successful investigators in this interesting department of physics, has shown that heat is polarised both by reflection and refraction. He has also succeeded in depolarising heat, and thereby proved that heat possesses the property of double refraction.

(Malus, *Théorie de la Double Réfraction*; Fresnel, *Mémoires de l'Institut*, 1824, 1826, 1827; Herschel's 'Treatise on Light,' *Ency. Metr.*; Brewster's 'Optics,' *Cabinet Cyclopædia*; various papers in the *Phil. Trans.* from 1813 to 1819; Airy's *Math. Tracts*, 2nd edit. 1831, and the various scientific journals.)

Polariscope. Any apparatus or instrument by means of which it can be ascertained whether light is in its ordinary state or has been polarised. This may be done in various ways. The polariscope proposed by Arago is formed of a tube closed at one extremity by a plate of rock crystal cut perpendicularly to the optical axis, and about five millimètres (or a fifth of an inch) in thickness, and having at the other end, where the eye is applied, a prism possessing the property of double refraction placed transversely to the axis of the tube. A beam of polarised light, after passing through the plate, is decomposed by the prism into two others, which are polarised at right angles to each other, and exhibit the complementary colours, varying with the position of the prism.

Polarity. In Physics, that property of bodies in consequence of which, when at liberty to move freely, they arrange themselves in certain determinate directions, or point, as it were, to given poles. Thus, an iron bar acquires polarity by magnetism, and, when suspended from a single point, arranges itself in the direction of the magnetic meridian, or points to the magnetic poles of the earth.

Pole (Gr. πόλος). In Surveying, a measure of length, containing 16½ feet or 5½ yards; it is the same as *rod*. Sometimes the term is used as a superficial measure; a *square pole* denoting 5½ × 5½ yards, or 30¼ square yards. For the meaning of the term pole as used in geometry, see COORDINATES, and POLES AND POLARS.

Pole Star. The pole star of a planet is the star towards which either end of its axis of rotation happens to be directed at any particular epoch. Thus the earth's axis prolonged, at the present time towards the north, passes by a star in the constellation *Ursa Minor*, which is thence called the pole star, or *Polaris*. Similarly, the axis prolonged southwards passes through the constellation of the Southern Cross.

Of course, the place in which the pole star of any planet will be found, depends upon the inclination of the axis of that planet to the plane of the ecliptic, and the direction of that inclination. Consequently, if we know the pole star of a planet, we know these two elements of the planet's equator.

In the case of the earth, owing to the phenomena of precession and nutation, the pole star is continually changing. If the axis remained parallel to itself, the pole star would always be the same; but we know that it varies in direction, still, however, preserving the same angle with the ecliptic, in such a way as to describe an entire cone in an interval of about 25,870 years; so that at the end of this period, the equinox, having accomplished an entire revolution on the terrestrial orbit, returns to occupy its initial position. The terrestrial axis, in executing this slow movement on the surface of the starry vault, describes a complete circle. The celestial poles, therefore, are incessantly variable. In fact, the northern pole, now quite near the pole star, is still approaching it. This diminution of angular distance will continue until the year 2120, when they will not be more than half a degree apart. This epoch passed, the pole will recede from Polaris, will pass from the Little Bear to Cepheus, then over the borders of the Swan. In 12,000 years, the bright star nearest to the north pole will be Vega in Lyra, which will then play the part of pole star, Canopus, in the southern

sky; will be equally found in the vicinity of the other pole.

Poles (Gr. πόλος). In Geometry and Astronomy, the extremities of an axis of rotation of a sphere or spheroid. In Spherics, the poles of a great circle are the extremities of the straight line perpendicular to the plane of the circle, and passing through its centre. The *poles of the ecliptic* are the points about which the stars are carried by the slow motion of the precession of the equinoxes; the *poles of the equator*, or *poles of the world*, are the two points about which the stars perform their diurnal rotation; the *poles of the horizon* are the zenith and nadir; the *poles of the meridian* are the points of the horizon due east and west.

Poles. In Physics, the points of a body in which its attractive or repulsive energy appears to be concentrated. Thus, the *poles of a magnet* are the opposite points in which the magnetic force is most strongly manifested.

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